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The report of the committee on buildings was of unusual value and interest. It dealt entirely with roofing, and may be regarded as almost a complete treatise on the subject. Naturally, a generous portion is occupied with bituminous materials, asphalt and the tars, as large quantities of these materials are used by the railways for roofing, and a good specification for built-up roof employing them is included. These, as well as the iron or steel roofings, must be regarded as temporary in a measure, and for more permanent construction slate and tile are to be preferred. Among the newer materials is reinforced concrete tile, and, while it has been extensively used, the extent of its endurance is regarded as largely experimental. The principal objection which may be offered to reinforced tiles is the fact that small cracks will allow moisture to penetrate to the expanded metal used for reinforcing, and as corrosion proceeds the metal expands or increases in volume, and a tendency to crack the tiles and open up larger spaces for leakage is the result. Fire protection was also fully considered, especially with respect to roofing, and two papers on this branch of the subject were included in the appendix. One relates to the tests at underwriters' laboratories in general, and the other illustrates a number of fire tests of roofing made by the Underwriters' Laboratory at Chicago. These tests must have an important influence on the development of fireproof roofings, as little work of real value has been done in this line heretofore.

The way committee reports are presented focuses attention on the conclusions of the committee. This is as it should be, so far as the association is an executive body which is to pass on recommendations for the manual. But it does not get out of the convention the informative discussion which should be aroused. The committee might direct attention in its report to the specific points on which there is disagreement, and especially those points on which more information is wanted. These could be made as prominent as are the conclusions, and, like them, be taken up seriatim for discussion. Also, more might be done by the members of the committee in getting hold of the men who should lead the discussion. Committee men might profitably spend more of their time after arriving at the scene of the convention in looking up the men with whom they have been in correspondence and others from whom they should expect valuable contributions. By getting personally in touch with these men, a committee can best get the discussion that it and the rest of the association need.

The "American Railway Engineering and Maintenance of Way Association" went out of existence yesterday and the "American Railway Engineering Association" was born. "The king is dead; long live the king!" The new name is a distinct improvement in one way: As President Fritch said at the annual dinner, it requires 50 per cent less time for utterance than the old one, which is economizing at a most exemplary rate. The captious might complain that the name is too comprehensive, as the mechanical department is also an engineering department; but the words "engineering" and "mechanical" have come to have clear and distinct meanings in the railway business. Maintenance of way and structures is so decidedly the most important part of the work ordinarily performed by the engineering department—at least in point of expenditures involved—that it was not inappropriate to emphasize it in the old name. But the word engineering embraces all the work done by the engineering department, including maintenance of way, and is therefore adequately indicative of the function of the association.

The discussion in the convention yesterday showed that the Daily Railway Age Gazette in its editorial on "The Manual and Current Practice," which was published yesterday morning, did not exaggerate the importance of more care being taken in future regarding the things that shall be adopted as recommended practice and, as such, put into the manual of the American Railway Engineering Association. The matter was one which evidently was in the minds of a large number of the leaders of the Association. It was brought squarely before the convention in the afternoon by a motion introduced by Hunter McDonald providing for the abolition of the manual. The remarks which this evoked showed that few, if any, of the members would like to see the manual abolished. Mr. McDonald frankly stated that he did not desire to see this done, but merely made the motion in order to get the entire question of what shall be put into it in future before the convention. No one who took part in the discussion controverted the contention that many things have been adopted as recommended practice in the past which ought not to have been adopted; all recognized the need for reform in this respect. The only question was as to how the reform should be effected. Mr.

McDonald's proposal that a board of review composed of men not on the board of direction should be created to pass on all committee suggestions regarding recommended practice before their submission to the association seemed to receive quite general approval. Probably the decision to refer the whole question to the board of direction for such action as it may deem proper, was the best that could be made. The sentiment of the Association that some action should be taken was made so clear that the board, no doubt, will take the question up for early disposition. Certainly nothing has yet occurred to indicate that the manual should be entirely abolished. Reform, not revolution, is what is needed. It should be made less bulky. Its contents should deal only with matters of real importance, it should include only widely accepted practice, which has been justified by experience; it should be in every case an expression of the "wisdom of the Association," as Mr. Wendt phrased it, and not a repository for expressions of the opinions of a comparatively small number of its members, even though they be those who, as committeemen, have given the most consideration of the particular subject dealt with. As Mr. Trimble of the Pennsylvania Lines said, there is often pressure to put things into the manual merely for the purpose of upholding the committee which has recommended such action, and often things are put into it when they are supported by only a small majority, or, perhaps, not even by a clear majority. Certainly the manual cannot properly be considered the "wisdom of the Association" unless its contents clearly express the results of the mature consideration of a very substantial majority of its members. It may be fortunate, or it may not be, that the time has come when every department of a railway must transact its business in the bright light of publicity, where it is subject to severe and often unfriendly scrutiny. But that this time has come is not open to controversy. Public men are constantly seeking new worlds of railway regulation to conquer. This is no reason why the Association should not incorporate in the manual as recommended practice anything which it believes all the railways should for their own good and for the good of the public adopt. But on the other hand, it is one of several very good reasons why the Association should not put into the manual anything that conditions may not make it entirely desirable for the roads to live up to in their actual practice.

RAIL SECTIONS.

The month of March is usually a convenient time for a review of the conditions surrounding the purchase of rails, as the report of the committee on rails of the American Railway Engineering Association is then published, and by this time most of the railways have placed their orders for their yearly requirements for rails. This year, however, while some of the eastern roads have placed liberal orders, the western lines apear to be ordering only about one-third their usual requirements. However, a sufficient number of rails have been ordered to indicate the general trend of opinion in regard to the sections. The prevailing types of rail sections may now be divided into two general classes which have characteristics corresponding with the A. R. A. sections A and B, the A section having a thin head and medium size flange and the B section having a thick head and a thick flange, and for a given weight the B section is shorter than the A. The section used by the Pennsylvania Railroad, while not exactly like the standard B type, has most of its characteristics, with the exception of the shape of the head.

The American Society of Civil Engineers section is similar to the A type, but with a thicker head and thinner flange. The New York Central section is quite similar to that recommended by the American Society of Civil Engineers, but with a thicker head. The 90 lb. A. R. A. rail is now used on a majority of the western prairie roads, with the exception of the Northwestern and the Northern Pacific, which use the B section. The B section is also used on the group of coal roads in Maryland and Virginia—the Baltimore & Ohio, the Chesapeake & Ohio and the Norfolk & Western. The Canadian Pacific uses the 85 lb. A section. While the B section is more perfectly balanced with regard to the areas of the head and base, experience in rolling the A section shows that these areas are sufficiently near alike to secure good work in the mills and little trouble from too much camber. The thickness of the flange in the A section is also sufficient to permit of proper temperatures at the last pass in the finished rail. The principal advantage of the A section is its greater stiffness, due to the height for a given weight of metal, and the proportion of the head area to other portions of the rail is such that the head obtains more working and compression under the rolls, thus consolidating the metal and making the steel a sounder structure. The B section is preferred by some roads because it is thought that a longer life will be obtained before the head is worn sufficient to condemn the rail. The heavy wear on the side of the rail is only found on curves, and the B section may, therefore, be best suited for roads having unusually heavy curvature. Other roads, like those on the prairies of the western states, do not need to provide for this wear, as the greater part of the track is straight or has comparatively light curvature. It is here possible to take advantage of the lighter head and the greater amount of work done on it in the rolls. On the straight roads the wear is principally on the top of the head, and the thin head of the A rail will permit of wear in this direction until the general surface is so uneven and wavy that the rails have to be condemned for that reason rather than for their lack of strength or irregular section. We have here then a good explanation of the reasons which have led to a preference for the A section on the prairie roads and the preference for the B section on the more crooked roads of the east, especially those in the mountains of Pennsylvania, Virginia and Maryland.

There are additional reasons for favoring one or the other section. Some regard the B rail best on account of its greater flexibility, not admitting that the extra stiffness of the A rail is a real advantage. This may also be a case where the rail section should have some relation to the character of the roadbed.

It is also claimed for the thick head of the B rail that it will not break down under the heavy wheel loads now imposed as easily as the thinner A head, even though there are no physical defects in the interior of the rail head. This is not sustained by the tests made by Mr. Wickhorst to determine this point. The A rail head is 1¼ in. thick at the edge for the 100 lb. rail. The 90 lb. section is almost as thick; and there is only $\frac{1}{32}$ in. difference in thickness of the heads of the A and B 80 lb. sections, which are over 1 in. thick. The Wickhorst tests showed that there was no sag of the 1 in. head under 60,000 lbs. rolling load (about double the weight on one driver of the heaviest locomotives), and there is no sag under 30,000 lbs. rolling load until the thickness of the head is reduced to ½ in. The tests show that the head of the A rail in sections 80 to 100 lbs. has sufficient thickness to sustain the heaviest rolling loads now imposed by regular service, and it permits of a margin of wear which would render the surface unfit for main track before it is so thin as to sag under heavy wheel loads.

The expense to the mills for a variety of rail sections must be paid eventually by the railways, and it is in the interest of economy that the number of sections be reduced to as few as possible. It ought to be possible for those railways which are using special sections to agree on either the A or B section, or on such modifications of those sections as will be acceptable to most railways, including those now using the A or B section.

ECONOMICS OF RAILWAY LOCATION.

The standing committee on the economics of railway location was organized about seven or eight years ago. It was understood that if it did the work outlined for it it would be among the most valuable of the association's important committees. The committee made its first report in 1907, before the eighth annual convention, and has reported regularly each year since. Its reports for 1907, where practically all that was known about train resistance was tabulated and discussed, and its report for 1910, where it attempted to lay out a foundation for computing the relative economic value of various line locations, were particularly valuable. During the past year, however, the committee has made very unsatisfactory progress, apparently through no fault of its members.

The committee for the current year received, among other instructions from the board of direction, the following:

"Continue the consideration of all questions connected with railway location, grades, lines and improvement of grades and lines affecting the economic operation with relation to traffic, tonnage, ratings, speed, density of traffic and financial considerations, with the special aim in view of establishing uniform methods and unit values for investigating and analyzing the relative changes and costs of comparative routes or proposed grade reductions and line corrections."

Its answer by its chairman at the end of a year's work was in effect that in order to carry its work further it must have information of a special character from the various railways, which information the roads either hold as confidential or consider that the compiling of the same in the form that may be of use to the committee requires the expenditure of more time and expense than they are willing to bestow. And the chairman concluded his report by recommending that the committee be discharged from further study unless the board of direction considered the work of sufficient importance to furnish such information as the committee might require. The chairman said in so many words that the work of the committee "must cease if the railways represented in this association cannot furnish the required statistics."

It is earnestly to be hoped that the board of direction will not consider for a moment the idea of discontinuing the work of this committee. There is probably work of more permanent value to future engineers and railway operators yet to be investigated and standardized by this committee than by any other committee of the association, except possibly the committee on electricity. No one knows yet what it is worth to any road of a given character of traffic to take out a degree of curvature or to reduce its grades by a tenth of one per cent. We have Wellington's, Webb's, Raymond's and Berry's individual conclusions on the subject, but we need the consensus of opinions from educated, practical engineers and railway operators on the subject. We need the results of the best examples of this kind of work tabulated, and conclusions drawn therefrom by experts in this field, so that we will have something more on these subjects than mere judgments or opinions.

Engineers are all agreed that there is an inferior limit for a road of given character and volume of traffic, beyond which it does not pay to reduce grades. Mr. Berry, in Bulletin 49, placed this inferior limit as probably at 0.4 per cent. for any road, but certain large roads in quite recent years have spent large sums in bringing their grades as low as 0.2 per cent. Has this money been wasted? Let this committee be kept at work till it answers this question for us. Let this committee be continued until it has told us definitely how we can learn when it will pay a road of given character and volume of traffic to double track its line and when it has double tracked it, how much greater per mile of road under the same traffic the maintenance of a double track will be than the single track. There are many similar problems to be solved. The committee outlined in its 1907 and 1908 reports the many desirable things there were for it to do.

If the large roads of the country that have made improvements in adding main tracks, in grade reductions, curve eliminations, etc., are really reticent about giving out an account of the effect of the changes on the cost and facility in operation it might reasonably be inferred that such improvements have generally not resulted as favorably as had been anticipated. No doubt there are such cases, and such cases are just what are needed to render valuable the work of the committee. There ought to be no difficulty in devising a satisfactory means of publishing such data without at the same time furnishing means of identifying the road. Any conclusion that such improvements have generally been found unsatisfactory is probably untenable because many of the large roads that are operated by some of the best railroad men in the country have adhered for years to certain plans and policies of improvements, and such plans and policies would certainly have been altered or abandoned entirely if they had proven unsatisfactory or unremunerative.

The difficulty that the committee is experiencing in securing information is probably rather to be largely accounted for by the fact that the work of compilation of the information for the purposes of the committee is greater than the roads have as yet been able to undertake. This might easily be accounted for by the fact that in recent years in the offices of most of the roads the requirements of the various state and interstate commissions have kept every available spare man busy on accounts and reports for those regulating bodies.

In view of the difficulties the committee has encountered in getting information suitable for its use, it has been suggested, without any reflection whatever upon the members of the present committee, for that committee in the reports already made has earned the gratitude of the association, that the work be placed in charge of a smaller committee made up of a somewhat different personnel. A committee of from three to six members only, and composed of members occupying the highest railway positions on large systems in the East, the Central West, the South, the Southwest and the Northwest, together with one special engineer student connected with one of the larger universities, has been suggested. Such a committee could much more easily receive the confidential information necessary. If it is feared that such a committee would not be able to do the necessary work for lack of time, perhaps the association could devise some means of meeting the expense of having the bulk of the work done by one or more engineers employed by the committee. The railways contributed freely to have the work of the committee on iron and steel structures carried on, and there is good reason to believe that if it is necessary, funds could be similarly raised for the important work of this committee.

STUDIES ELECTRIFICATION OF AMERICAN RAILWAYS.

Knutt W. Bildt, mechanical and electrical engineer of the Luossavaara-Kürunavaara Mining Company, Kiruna, Sweden, was in attendance at the convention yesterday. Mr. Bildt is concerned in plans that are being made by the Swedish government for the electrification of certain of its railways, and is seeking light on the subject of electrification from American railway engineers who have had practical experience in dealing with the matter.

The Delaware, Lackawanna & Western expects to install 40 miles of automatic block signals on single track on the Utica division, and 20 miles on the Phillipsburg branch. This road also expects to install electro-pneumatic interlocking machines at Scranton and Port Morris.

Proceedings.

The Thursday morning session of the American Railway Engineering and Maintenance of Way Association was called to order at 9:30 o'clock by President Fritch.

SIGNS, FENCES AND CROSSINGS.

The following subjects were assigned:

(1) Consider revision of Manual.

(2) Report on ways and means for securing a proper quality of fence wire to resist corrosion and secure durability.

(3) Continue investigation of the use of concrete fence posts and submit recommendation.

(4) Continue investigation as to the best form of track construction and flangeways in street crossings and paved streets.

W. D. Williams.

Chairman, Committee on Signs, Fences and Crossings.

REVISION OF MANUAL.

No changes are recommended further than those submitted in the report for 1909, which the committee recommends to be adopted and included in the manual.

PROPER QUALITY OF FENCE WIRE.

The committee has been energetic in pursuing its investigations, scrutinizing and testing out every new theory advanced pertaining to the preservation of wire and proving its merits or demerits. Thus far, however, no new process has been discovered which offers any advantage over the old, and it is the opinion of the committee that applied galvanized coating, by special treatment, is the best and only known economical process for protecting wire used in railway fences against corrosion.

Conclusion: The committee recommends the use of wire which has received a special galvanized coating to stand a test of four one-minute immersions in the standard copper sulphate solution, the galvanizing to be done preferably after weaving.

CONCRETE FENCE POSTS.

The tests, observations and use of concrete fence posts during the current year indicate:

(1) That concrete fence posts are practicable, durable and economical.

(2) The eight-foot post is recommended.

(3) Posts of cross-section approaching a square form are easiest made and most suitable for fencing.

(4) Spacing, same as recommended for wood posts.

(5) Stone or gravel used in mixing concrete for fence posts should pass a half-inch square mesh. Concrete should be mixed wet, in a batch mixer, and poured into the moulds. The poured posts are a little over 25 per cent. stronger than tamped posts of the same size, mixture and reinforcement; they are also better able to withstand the action of frost and alkali. Experience shows that extra precaution should be used in the selection of material, mixing of concrete and handling and curing the posts. For the best results, posts should be allowed to remain in the yard undisturbed for at least sixty days after coming from the moulds.

(6) Breakage in handling and transportation should not exceed three-tenths of one per cent.

Conclusion: Concrete fence posts are recommended for railway fences.

FLANGEWAYS IN STREET CROSSINGS.

On this subject the committee reports progress. The sub-committee having it in hand have worked hard to formulate plans and make recommendations, but the subject is of so much importance, the committee feel that more time should be given for their investigation.

The report is signed by: W. D. Williams (Cin. Nor.), chairman; K. J. C. Zinck (Gr. Tr. Pac.), vice-chairman; A. M. Funk (B. & O.), W. H. Hoyt (D. M. & N.), E. R. Lewis (Mich. Cent.), Joseph Mullen (C. C. C. & St. L.), W. J. Burton (Mo. Pac.), C. H. Stein (Cent. of N. J.), E. J. Steinbeck (Ill. Cent.).

Discussion on Signs, Fences and Crossings.

Mr. Zinck: The committee asks that the association refer this report back to them for further work during the coming year. I make a motion to that effect.

The President: You will note that the committee has made certain recommendations, but without further consideration, they think it is proper to refer the matter back to the committee in order that they may make a more complete report next year.

The motion was carried.

WATER SERVICE.

The following sub-committees were appointed:

Revision of the Manual: Robert Ferriday, A. D. Schermerhorn.

Water tank specifications: J. L. Campbell, G. H. Herrold, W. A. Parker, C. A. Morse.

Water stations for track pans: E. G. Lane, L. P. Rossiter, H. M. Church, James Burke, A. Mordecai.

C. L. Ransom.

Chairman, Committee on Water Service.

Recommendations for next year's work: C. L. Ransom, Robert Ferriday, J. L. Campbell, E. G. Lane.

REVISION OF MANUAL.

No further revision was suggested at this time.

WATER TANK SPECIFICATIONS.

The reinforced concrete tank was considered as rather a new departure, and the following specifications and design are submitted as a progress report only:

Specifications for a Reinforced Concrete Water Tank.

1. The tank shall be of reinforced concrete, as shown on the drawings.

2. The capacity of the tank shall be within the limits

of 50,000 and 106,000 gallons, exclusive of the lower 20 ft. of the tank. The height of the tank from bottom to top of shell shall be 40 ft. A diameter of 30 ft. is recommended. On this basis the drawings have been made. The latter shall be made to meet the requirements of the height and diameter selected by the engineer.

3. The tank is designed to deliver water to locomotives through water columns. The floor of the tank shall not be lower than the tracks served.

4. In earth, the excavations for the foundation and pipes shall be as deep as the lowest frost line, with a minimum depth of 4 ft. In rock, only the trenches for the pipes shall be carried below the action of frost. In earth, the bottom of excavations shall be thoroughly tamped to discover and compact any soft places. If the earth will not sustain the total load, including wind pressure, without material or unequal settlement, the foundation shall be supported on piles of the number, size and arrangement as determined by the engineer. Such piles shall conform to the specifications of this association for piling, as selected by the engineer.

5. The foundation shall consist of a disk of concrete, as shown. If the depth of frost is excessive, this disk may be carried on broken rock compacted in the bottom of the excavation, but the minimum vertical thickness of the concrete foundation, exclusive of the tank floor, shall be 42 in.

6. The valve box for the piping shall be constructed as a part of the foundation, as shown. The top and bottom of the box shall be reinforced by steel rods laid both ways and doubled around the pipes and the manhole. The manhole frame shall be in one piece of first-class cast-iron with a double seat and a double cover. The latter shall preferably be of wood. When low temperatures require to prevent freezing within the valve box, an air space shall be constructed in the middle of that portion of the box walls outside of the tank foundation. When the absence of low temperatures permit, the air space and the lower manhole cover may be omitted.

7. The reinforced concrete floor on the foundation shall be constructed, as shown, giving its surface a sidewalk finish without plastering.

8. The reinforced concrete shell shall be constructed, as shown, building in the concrete fillet in the angle at the bottom.

9. The reinforced concrete roof, including manhole and cover, shall be constructed, as shown, finishing top of roof as specified for the floor. Where ice will not form to an injurious or troublesome extent and sunlight will not cause vegetable growth in the water, this roof may be omitted at the discretion of the engineer.

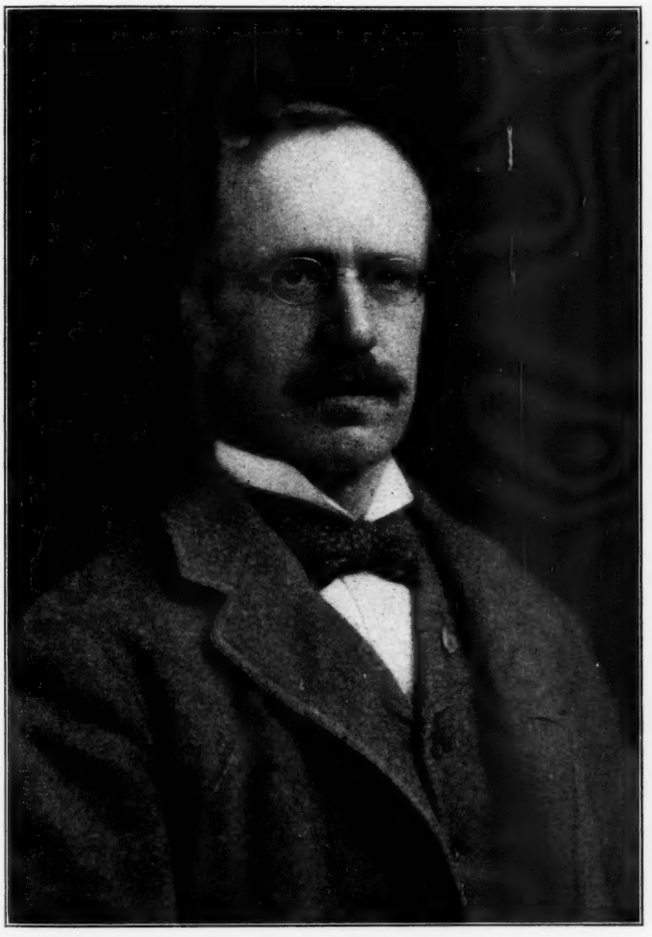
10. The tank shall be equipped with cast-iron piping and standard gate valves, as shown. There shall be a tank supply pipe, a water column supply pipe, an overflow pipe and a washout pipe, the latter two being combined in the valve box beyond the valve closing the washout pipe. There shall be no valve in the overflow pipe. For a gravity supply, the tank supply pipe shall be carried to the top of the tank and be capped by a float valve. The washout pipe shall terminate flush with the tank bottom. The water column pipe shall extend several feet above the bottom but not higher than the top of the water column. All piping shall pass through the bottom of the tank, preferably in cast-iron stuffing boxes with lead joints, as shown, but other forms of stuffing box and joint may be used.

All pipes and castings, in quality, manufacture and inspection, shall fulfill the requirements of the specifications of the New England Water Works Association for cast-iron pipe.

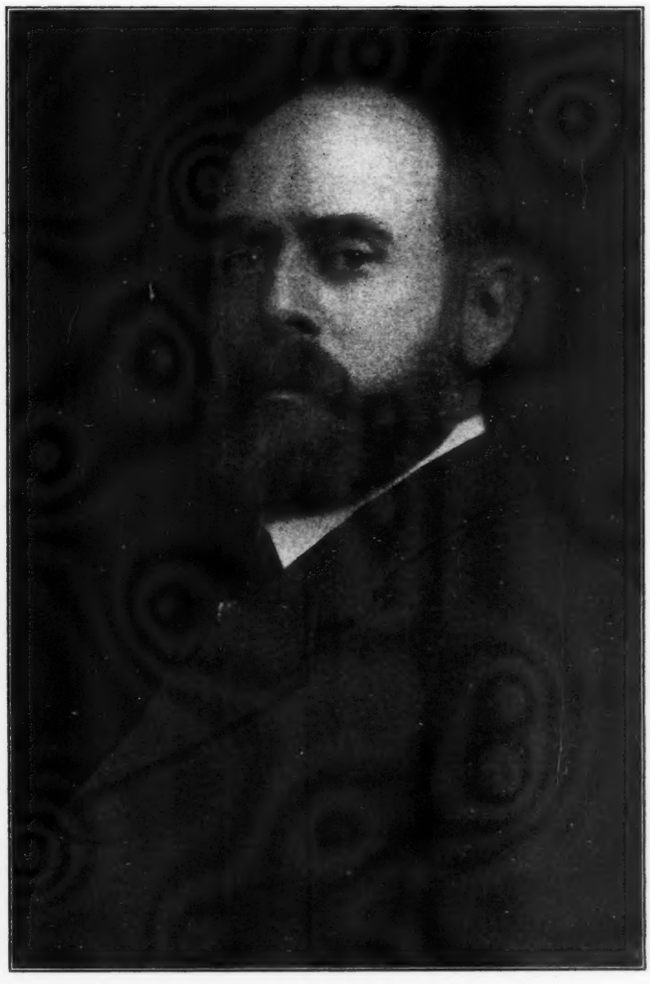
The weights and diameters of the pipes shall be determined by the engineer. No pipe shall have an inside diameter less than 4 in.

11. The cast-iron sludge pipe shall be carefully constructed, enclosing in the concrete and doubling the reinforcing rods around it, as shown. When absence of sediment in the water justifies, this pipe may be omitted.

12. The tank shall be equipped with a gage, indicator



W. C. Cushing, President.



Chas. S. Churchill, First Vice-President.

and float, according to the design or selection of the engineer.

13. The steel ladder shall be constructed, as shown and as designed, or selected by the engineer. The ladder shall be carried by connecting straps or angles resting on the roof. It shall not be anchored to the tank shell. The steel shall conform to the specifications of this association for steel bridges.

14. The concrete in the tank foundation and the side walls of the valve box shall be a 1-3-5 mix, made and laid in accordance with the specifications of this association for Portland cement concrete.

15. The top and the bottom of the valve box and the tank floor, shell and roof shall be made of reinforced concrete.

16. Reinforced concrete shall be a thoroughly uniform mixture of cement, sand, stone and water completely enveloping the reinforcing rods.

17. The volume of the stand shall be 5 per cent. in excess of the volume of the voids in the stone. The volume of the cement, considering 100 lbs. of it as 1 cu. ft., shall be 25 per cent. in excess of the volume of the voids in the mixed sand and stone. The engineer shall determine the voids and proportions.

18. The volume of the water shall be sufficient to give the concrete a fluidity that will cause it to flow and mould itself in the forms without tamping.

19. The concrete shall preferably be mixed by mixing machines. The method used shall yield a complete and even mixture.

20. All dirt and foreign matter shall be excluded from all materials, concrete and stages of the work.

21. The concrete, after mixing, shall be poured and worked into final position in the forms before its initial set is complete, and it shall not thereafter be disturbed. As it is thus placed, it shall be thoroughly worked by long, flat, thin-bladed tools in a manner that will eliminate all voids and air pockets and produce unbroken mortar faces against all forms and secure perfect contact with every part of all reinforcing rods.

22. The surface of concrete shall be clean and wet when concrete is laid thereon. The surface, if hardened, shall also be mopped with cement grout immediately in advance of placing fresh concrete. Smooth or finished mortar surfaces shall be avoided where additional concrete is to be placed. If necessary, as in the joints between the tank floor, shell and fillet, old surfaces shall be tooled, cleaned and grouted before concrete is placed thereon.

23. A rapid drying out of concrete shall be prevented by regular, frequent and continued wetting until all danger of arrested setting and hardening is past, as the engineer shall direct.

24. Freezing of concrete before it has finally set shall be prevented.

25. Any concrete broken or displaced in any manner after having set shall be removed from the work.

26. The cement shall conform to the specifications of this association for Portland cement. It shall retain its original purity and qualities until it is incorporated into the work. Deteriorated or otherwise damaged cement shall not be used.

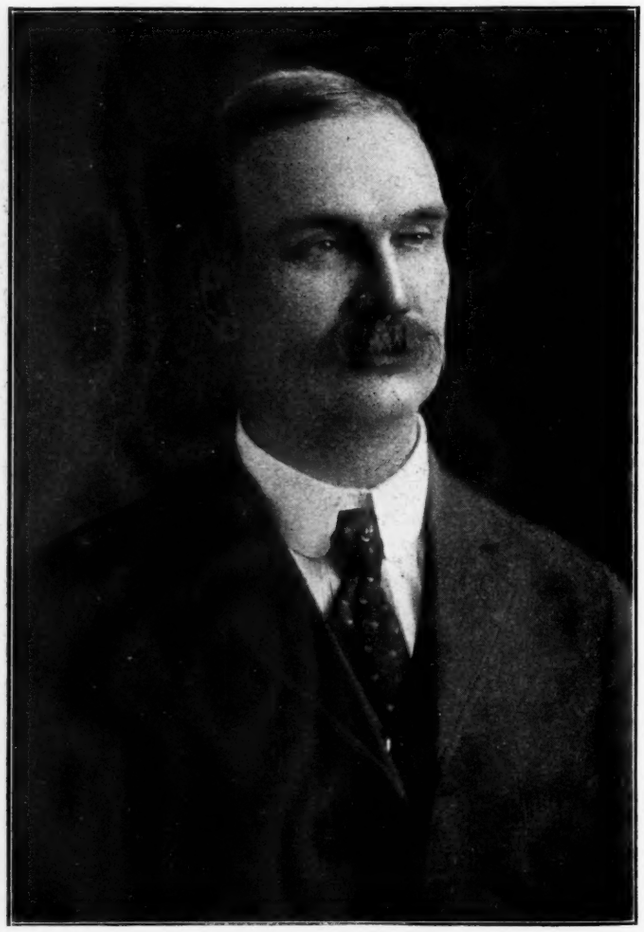
27. The sand shall be clean, sound and sharp and it shall be of graded sized grains giving a minimum of voids.

28. The stone shall be clean, sound and durable. The word "stone" includes broken rock and gravel. The stone shall be of graded sizes giving a minimum of voids. All of it shall be able to pass through a circular hole having a diameter of ¾ in.

29. The water shall be clean and free from anything injurious to the concrete.

30. The concrete forms shall be made of metal or of dressed and matched lumber. They shall be accurately made and erected, be water tight, and shall have ample strength and rigidity to prevent bending and warping under the load and action of the concrete. They shall be erected in such sections and courses as will permit the concrete to be poured and worked as above specified. No device for holding the forms that would leave a hole through the concrete shall be used. Wires passing through the concrete shall be nipped off beneath the concrete face.

Edwin F. Wendt, Second Vice-President.



G. H. Bremner, Treasurer.

31. Any break in the concrete surfaces not impairing the integrity of the structure shall be pointed with cement mortar, as the engineer shall direct. Any other imperfections in the concrete shall be treated and remedied as the engineer shall direct.

32. The concrete shall be reinforced by steel rods of the form, size, number and arrangement, as shown. They shall be wired at intersections with each other and be maintained in required position as they are buried in the concrete, at which time they shall be free from dirt and scale. Splices in rods shall be lapped 42 diameters or sides. No splice shall be opposite a splice in an adjacent line of rods. Throughout the splice the ends of the rods making it shall be 1½ diameters or sides apart in the clear. There shall be not more than four splices in the circumference of a tank 30 ft. in diameter. Unnecessary splicing shall be avoided.

33. The reinforcing rods shall be plain or deformed. Their tensile strength per sq. in. shall be between 60,000 and 90,000 lbs. Their elastic limit shall be not less than ½ of their tensile strength. They shall not be stressed more than one-third of their elastic limit. Any rod shall be capable of being bent cold on a radius of three diameters or sides through 180 degrees without sign of fracture.

34. A dense, even mixture of concrete as herein specified for reinforced concrete shall be the primary expedient to secure water-tight concrete. This may be supplemented by mixing with the cement some form of waterproofing compound of proved efficiency and now obtainable from manufacturers.

Where the concrete can be worked before it has set, the surface shall be thoroughly troweled until a dense mortar face is secured. Concrete surfaces already set may be plastered by rich cement mortar, but surfaces so treated shall first be cleaned and roughened by steel brushes or equivalent, and the plastering shall be applied on a fresh coat of cement grout mopped on the surface.

In addition, if necessary, separate and alternate washes of soap and alum in the order named shall be applied to the dried and hardened concrete surface. The number of washes should be not less than two of each, with a 24-hour interval between each. The proportion should be approximately ¾ lb. of soap and ⅛ lb. of alum per gallon of water. These proportions may be varied if better results are thereby secured. The soap wash shall be applied boiling hot, without causing frothing. The alum wash should have a temperature between 60 and 80 degrees Fahrenheit.

In lieu of these washes approximately 1 per cent., by weight, of powdered alum may be evenly mixed with the cement, in which case the same proportion of soap shall be dissolved in the water in making the concrete.

In lieu of soap and alum, waterproofing paint having an asphalt base to be applied hot or cold, and now obtainable from manufacturers, may be used. In all washing or painting the concrete surface treated shall be dry and clean and the temperature should be above the freezing point.

35. The weight of water shall be assumed to be 63 lbs. per cu. ft. Wind pressure, acting in any direction, shall be assumed to be, in pounds, thirty times the product of the height by two-thirds of the diameter of the tank, in feet.

Specifications for Wooden Water Tank.

1. The tank shall be a wooden tub carried on timber posts supported on concrete piers, as shown on the drawings. These specifications provide for an all-wood structure above the foundation, as shown.

2. A diameter of 24 ft. and a height of 16 ft. (outside measurement) are recommended for the tub of this tank. Other dimensions may be used, but the design shall conform to the requirements of these specifications.

3. The tank is designed to deliver water to locomotives through water columns. The bottom of the tub shall be not less than 20 ft. above the tracks served.

If water columns are not used, the location of the tank and the necessary tank fixtures shall be selected by the company.

4. Water shall be assumed to weigh 63 lbs. per cu. ft. Wind pressure in pounds acting in any direction on the tub shall be assumed to be thirty times the product of the height by two-thirds of the diameter of the tub. The wind pressure on the substructure shall be assumed at 30 lbs. per sq. ft. of its surface acted on.

5. Necessary anchorage shall be provided to the foundation on the basis of an empty tub, as the engineer shall design and require.

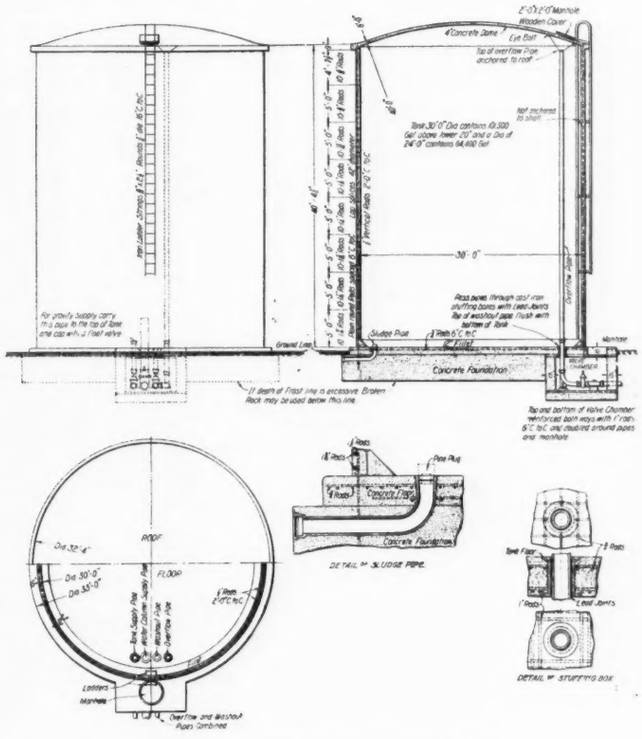
6. In earth, the excavation for the piers and frost pit shall be deep enough to permit the pipes to be laid below the frost line, with a minimum depth of 4 ft. In rock, only the excavations for the frost pit and the pipe trenches shall be carried below the action of frost.

On earth, the total load including wind stress shall not exceed the safe load for that earth. If the earth will not carry this load without material settlement, piling shall be put in as the engineer shall direct. Such piling shall conform to the specifications of this association for piling, as selected by the engineer. Earth foundations shall be thoroughly tamped to detect and compact any soft places therein.

7. The piers and frost pit shall be of concrete of a 1-3-5 mix, made and laid according to the specifications of this association for Portland cement concrete and to the forms and dimensions, as shown, including the proper setting of all anchor bolts.

8. The substructure shall be constructed, as shown. The timber shall be pine, oak, cypress or redwood, S 4 S for painting, and conforming to the specifications of this association for No. 1 R. R. bridge timber. It shall be accurately framed and erected, properly tightening all bolts and tie rods.

9. All rods and bolts shall be iron or steel of the quality hereinafter specified for tank hoops. O. G. washers shall be used under heads and nuts of bolts and tie rods.



Reinforced Concrete Water Tank.

10. The tub shall be made of pine, cypress or redwood, sound, seasoned, out of wind, free from shakes, sap, pitch pockets or streaks, unsound knots, loose knots, knots in clusters, and large knots extending through the material. Small, loose or unsound knots may be bored out if the holes are thoroughly plugged. Material having knots in its edges will not be accepted.

11. The bottom of the tub shall be made of 3-in. planks, S 4 S, and accurately cut and planed to uniform thickness and width. The ends shall be cut to the true circle of and shall fill the croze in the staves. Each plank shall be in one piece without joint or splice. The planks shall be joined by ¾-in. by 3-in. wood dowels on 30-in. centers along each joint. The bottom shall be laid directly on the floor joists.

12. The staves shall be of uniform width, end to end, and shall be made of 3-in. planks, S 4 S, with edges accurately planed on radial lines from center of tub. Each stave shall be in one piece, without joints or splice. The croze in each stave shall be accurately cut to uniform dimensions on one circle for all staves. The croze shall be 3 in. in the clear from the end of the stave.

13. The tub hoops shall be half oval, half round, or

round. They shall preferably be made of wrought-iron. They may be made of steel.

Wrought-iron shall be made of pure puddled iron having a tensile strength of 50,000 lbs. and containing of

Sulphur.....	not more than	.02	per cent.
Phosphorus.....	"	"	"	.005	"
Carbon.....	"	"	"	.02	"
Manganese.....	"	"	"	.00	"
Silicon.....	"	"	"	.00	"

Steel shall conform in physical and chemical properties to the specifications of this association for steel bridges.

Each hoop shall be in three equal sections.

14. Each hoop shall be cleaned (preferably at the factory) of dirt, rust and scale, and in that condition shall be heated to 300 degrees Fahrenheit and be dipped in pure asphalt having that temperature which shall be maintained during the immersion which shall continue not less than one minute.

15. Hoops shall have round threaded ends passing through lugs. The joint used shall be as designed or selected by the engineer. It shall be as strong as the hoop.

16. Hoops shall be of one size with the spacing varied, limiting the maximum space to 24 in. c. to c. of hoops.

17. Hoops shall be so spaced that, for wrought-iron, the stress per sq. in. on net section shall not exceed 10,000 lbs., and for steel 12,000 lbs. Threaded hoops shall preferably have upset ends, but a larger hoop giving the required area under thread without upsetting may be used.

18. The roof shall preferably be built in the form of a flat dome, as shown, but other forms may be used.

19. Each joist of the dome form shall preferably be in one piece of full-sized 2-in. lumber, but the longer joists may be built up to an equivalent section. The top of each joist shall be cut to a template having a radius of 84.5 ft., each end of the joist having a depth of 4 in. The length of each joist is determined by its position within the circle having a diameter of 25 ft. 6 in. and cutting the ends of the joists, as shown.

20. On the roof joists, 1-in. by 6-in. sheathing shall be laid solid and shall be cut to a circle having a diameter of 26 ft., as shown.

21. The roof eave shall be finished by 1-in. lumber and quarter rounds built on the ends of the joists, as shown.

22. The sheathing shall be covered by metal, bituminous felt or burlap roofing, tar and gravel, asphalt, mastic, or other prepared waterproof roofing, limiting the selection to brands of proved efficiency. If other than the dome form of roofing is used, shingles or barn boards may be used.

23. The manhole in the roof shall be constructed as shown.

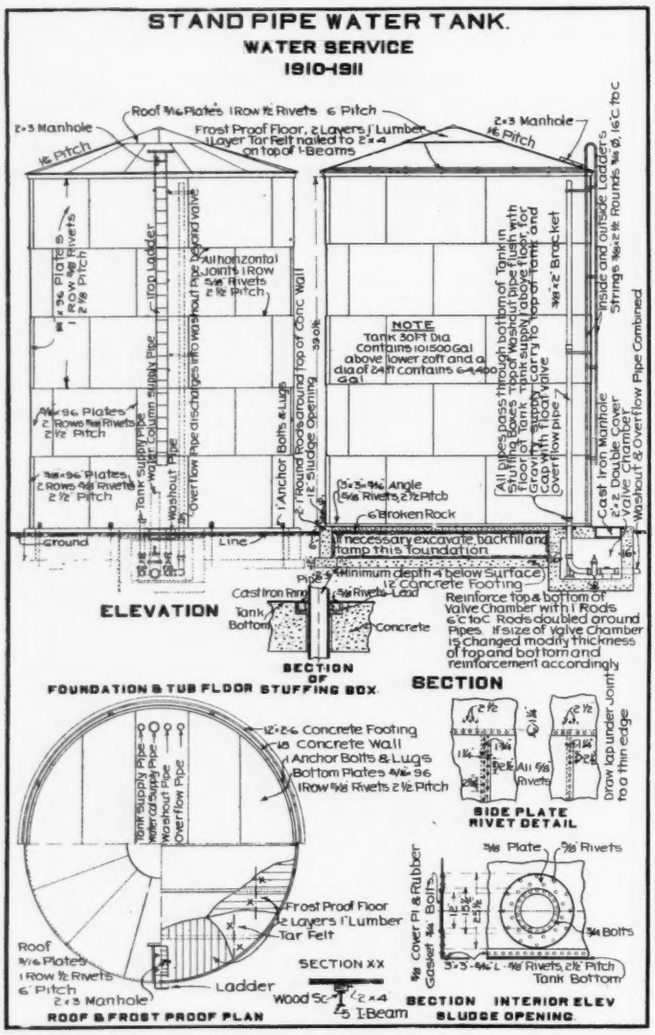
24. When required for frostproofing the roof shall be sealed, as shown. Where ice will not form to an injurious or troublesome degree and sunlight will not cause vegetable growth in the water, the entire roof and ceiling may be omitted.

25. The frost shaft, extending from the frost pit to the bottom of the tub, shall be constructed, as shown, enclosing it by multiple walls of 1-in. by 6-in. lumber, S 1 S and 2 E, separated by 2-in. by 4-in. studding on edge or side. Each wall shall have two courses of lumber separated by a layer of heavy tar felt. The outside course shall be tongued and grooved. The number of walls shall be sufficient to prevent water in the enclosed pipe from freezing. A frostproof door in one side of the shaft shall be constructed as designed by the engineer.

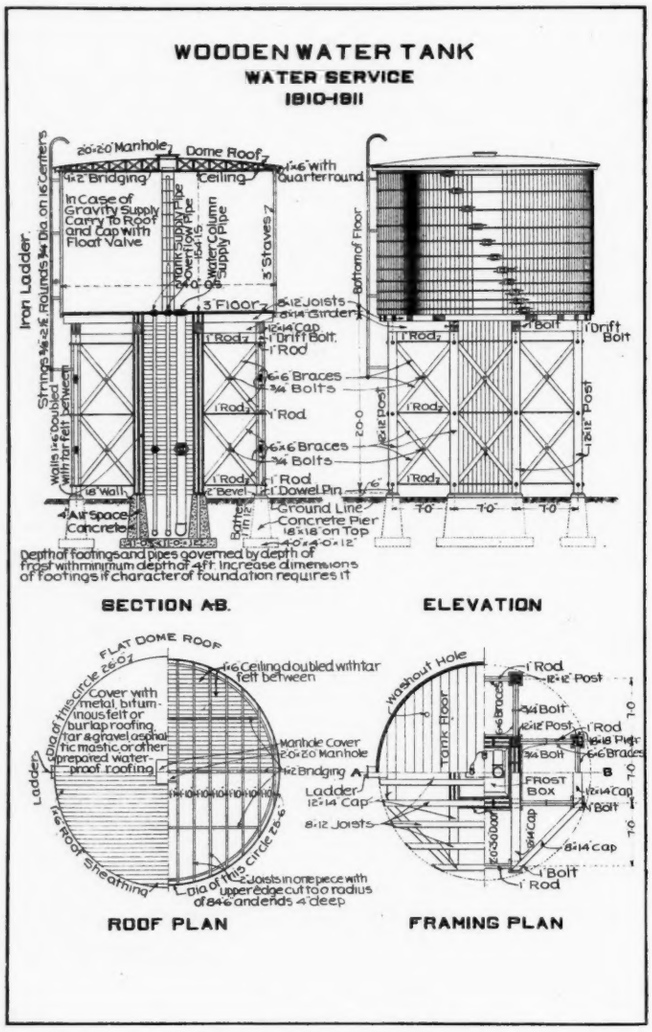
Where ice will not form, the entire frostproofing, including pit, may be omitted.

26. All lumber in the roof and frostproofing shall be No. 1 common, as rated by the Lumbermen's Association for the district supplying the material.

27. The tank shall be equipped with a tank supply pipe, a water-column supply pipe and an overflow pipe, as



Standpipe Water Tank.



Wooden Water Tank.

shown. The first two shall be provided with gate valves. For a gravity supply the tank supply pipe shall be carried to the top of the tank and capped by a float valve. The sizes of the pipe shall be determined by the engineer. No pipe shall have an inside diameter less than 4 in. All pipes shall pass through the bottom of the tank by two standard flanges full bolted with gaskets. For a pressure gravity supply, a stuffing box in lieu of flanges for the tank supply pipe may be used if necessary to prevent leakage. All pipes shall be enclosed in the frost shaft and pit and leave the latter below the frost line.

28. In the bottom of the tank outside of the frost shaft a sludge hole with plug shall be constructed as designed or selected by the engineer.

29. When the tank is finished, the hoops properly tightened and the wood saturated, the tub shall be water tight. No foreign material shall be used in making the joints in the tub.

30. The tank shall be equipped with a gage, indicator and float as designed or selected by the engineer. The clearance between the gage board and the tub shall not be less than 1 in.

31. The ladders shall be constructed, as shown, and as designed, or selected by the engineer.

32. All exposed woodwork shall be painted with one priming and two finishing coats, using the company's standard paint and colors for such work. All wood to be painted shall be dressed.

Specifications for an Iron or Steel Water Tank.

1. The tank shall be of iron or steel on a foundation, as shown on the drawings.

2. The capacity of the tank should be within the limits of 50,000 and 100,000 gallons, exclusive of the lower 20 ft. of the tank. The height of the tank from bottom to top of shell should be within 12 in. of 40 ft. A diameter of 30 ft. is recommended. On this basis the drawings have been made. The latter shall be made to meet the requirements of the height and diameter selected by the engineer.

3. The tank is designed to deliver water to locomotives through water columns. The floor of the tank shall not be lower than the tracks served. If water columns are not used, the location of the tank and the necessary tank fixtures shall be such as shall be selected by the company.

4. See specification No. 4 for reinforced concrete tank.

5. The foundation shall consist of a ring of concrete under the shell of the tank enclosing a broken rock foundation, as shown. Under the broken rock the earth shall be excavated, back filled and tamped to such depth and in such manner as may be necessary to secure proper support.

6. See specification No. 6 for reinforced concrete tank.

7. When wind pressure requires, the tank shall be anchored to the foundation by anchor bolts and lugs, as shown, and as designated or approved by the engineer.

8. The concrete in the foundation of the tank and the side walls of the valve box shall be a 1-3-5 mix, made and laid inaccordance with the specifications of this association for Portland cement concrete. In the top and bottom of the valve box the concrete shall be a 1-2-4 mix, made and laid in accordance with the specifications of this association for reinforced Portland cement concrete. The extreme fiber stress on concrete shall not exceed 600 lbs., and in steel shall not exceed 12,000 lbs. per sq. in. as given by the straight line formula.

9. These rods and bolts shall be of steel and in quality they shall fulfill the requirements of these specifications for the steel in this tank.

10. See specification No. 10 for reinforced concrete tank.

11. A sludge hole shall be constructed in the side of the tank at the bottom, as shown, and as designed or approved by the engineer. This opening shall preferably have a reinforcing ring and a cover plate, as shown, but other forms, including cast-iron, may be used.

If the absence of sediment in the water justifies, this opening may be omitted.

12. The tank roof shall be constructed of metal, including manhole, as shown. If necessary to prevent ice forming to an injurious or troublesome degree over the water in the tank, a ceiling shall be constructed under the roof of doubled 1-in. by 6-in. lumber, No. 1 common of the Lumbermen's Association for the district supplying the material, with a layer of heavy tar felt between. This ceiling shall be nailed to 2-in. by 4-in. nailing strips, bolted to the top of I-beams carrying the ceiling. The latter shall be standard beams of proper weight and spacing for the span and load and shall be carried by the shell of the tank through standard connections.

Where ice will not form, as specified above, and sunlight will not cause vegetable growth in the water, the entire roof and ceiling may be omitted, in which event finish top of tank shell by a ⅜-in. by 3-in. by 3-in. angle.

13. The ladder shall be constructed, as shown, and as designed or selected by the engineer. The metal in this ladder, in quality and manufacture, shall fulfill the requirements of these specifications for the metal in the tank.

14. Metal Specifications.—The metal in these tanks shall be wrought-iron or open-hearth steel.

The iron shall be manufactured from pure puddled iron having a tensile strength of 50,000 lbs. per sq. in. This iron shall contain of

Sulphur.....	not more	than		.02	per cent.
Phosphorus.....	"	"	"	.005	"
Carbon.....	"	"	"	.02	"
Manganese.....	"	"	"	.00	"
Silicon.....	"	"	"	.00	"

The steel shall conform in physical and chemical properties to the specifications of this association for steel bridges.

The rivets shall be ⅝-in. in diameter.

15. The weight of water shall be assumed to be 63 lbs. Wind pressure, acting in any direction, shall be assumed to be, in pounds, thirty times the product of the height by two-thirds of the diameter of the tank in feet.

16. Unit stresses shall not exceed the following:

For Iron:

(a) Tension in plates, 10,000 lbs. per sq. in. on net section.
(b) Shear in plates, 8,500 lbs. per sq. in.
(c) Shear on rivets, 10,000 lbs. per sq. in.
(d) Bearing pressure on field rivets, 18,000 lbs. per sq. in.

For Steel:

(a) Tension in plates, 12,000 lbs. per sq. in. on net section.
(b) Shear in plates, 10,000 lbs. per sq. in.
(c) Shear on rivets, 10,000 lbs. per sq. in.
(d) Bearing pressure on field rivets, 18,000 lbs. per sq. in.

17. Plates forming the shell of the tank shall be cylindrical and of different diameters, in and out, from course to course.

18. All workmanship shall be first-class. All plates shall be beveled on all edges for caulking after being punched. The punching shall be from the surface to be in contact. The plates shall be formed cold to exact form after punching and beveling. All rivet holes shall be accurately spaced. Drift pins shall be used only for bringing the parts together. They shall not be driven with enough force to deform the metal about the holes. Power riveting and caulking should be used. A heavy yoke or pneumatic bucket shall be used for power-driven rivets. Riveting shall draw the joints to full and tight bearing.

19. The tank shall be made water tight by caulking only. No foreign substance shall be used in the joints. The caulking shall preferably be done on the inside of tank and joints only. No form of caulking tool or work that injures the abutting plate shall be used.

20. The minimum thickness of plates in the cylindrical part of tank shall be ¼-in. and in the bottoms $\frac{5}{16}$-in.

21. Lap joints shall be used for all horizontal joints and for vertical joints in plates not more than ⅜-in. thick. With thicker plates, double butt joints, with inside and outside straps, shall generally be used. The edge of the plate in contact at the intersection of horizontal and vertical lap joints shall be drawn out to a uniform taper and thin edge.

22. The diameter of rivet holes shall be $\frac{1}{16}$ in. larger than the diameter of the rivets used. The punching shall conform to the specifications of this association for such work on steel bridges. A close pitch, with due regard for thickness of plate and balanced stress between tension on plates and shear on rivets, is desirable for caulking.

23. The tank shall be equipped with a gage indicator and float, according to the design or selection of the engineer.

24. After being completely erected, caulked and cleaned of dirt, rust and scale, all exposed metal work shall be painted or treated with such coat or coats of paint or metal preservative as shall be selected by the railway company.

The report is signed by C. L. Ransom (C. & N. W.), chairman; Robert Ferriday (C. C. C. & St. L.), vice-chairman; James Burke (Erie); J. L. Campbell (E. P. & S. W.); H. M. Church (B. & O. S. W.); G. H. Herrold (C. G. W.); E. G. Lane (B. & O.); A. Mordecai, consulting engineer;

C. A. Morse (A. T. & S. F.); W. A. Parker (St. Jos. & Gd. Is.); L. P. Rossiter, Hazelwood, Pa.; A. D. Schermerhorn (Un. Pac.).

Discussion on Water Service.

(The secretary then read Par. 2, 3, 4 and 5.)

J. L. Campbell (E. P. S. W.): I would suggest that it would be better if we would transpose the phrase in paragraph 5, making it read: "Necessary anchorage to the foundation shall be provided."

The President: If there is no objection, that will be done.

J. P. Snow (B. & M.): I object to having the concrete so definitely specified in paragraph 7. The foundations might be made of stone masonry and be made all right. It says, "the piers and frost pit shall be of concrete." I think that is a bad word to put in the manual in that connection.

The President: The committee will accept Mr. Snow's suggestion, and will change that to "masonry."

Mr. Stephens: I think that the comma after "small" in paragraph 10 should be eliminated, so that it would read, "small loose or unsound knots."

Mr. Campbell: It is the intention of these specifications to distinguish between small knots and loose knots.

H. A. Lloyd (Erie): It seems to me the specification for the kind of wood is a little too general. The family of pine is very large, and in using Norway pine you might get bad results.

Mr. Campbell: In the word "pine" the committee intended to include any wood that would properly come under that general class of timber, which would include yellow pine, white pine, douglas fir, and possibly other classes of pine that would be entirely suitable.

G. D. Brooke (B. & O.): I hardly think it is the intention of the committee that a large loose knot should be bored out and the hole plugged.

W. H. Courtenay (L. & N.): It seems to me it would be better to omit the comma.

The President: The committee will accept that.

C. H. Stein (C. of N. J.): In reference to the first line of the paragraph, there should be something more specific in regard to the kind of pine. If we place a specification like this in the hands of the contractor, he might make a tank out of some species of pine which is very objectionable, and I would like to ask, for information, whether any kind of cypress would be suitable for a water tank?

Mr. Ranson: Quite a number of southern firms are making tanks out of cypress and many southern roads are using them.

Mr. Ranson: The committee would be glad to have suggestions as to changing this reading to make it plainer.

A. K. Shurtleff (C. R. I. & P.): My suggestion is that this be left blank, to be filled in by the company selecting the wood they desire the tank to be made of. The specification should be specific.

Mr. Campbell: This committee last year brought in a specification for tanks full of blanks, and the association wanted the blanks filled in. The idea in the preparation of these specifications was to cover the quality of the wood—to make it as general as the committee thought permissible, and then specify the quality. It is true that "pine" would admit any kind of pine, but the specification says it should be sound and seasoned. I believe it is the opinion of the committee that any sound and seasoned wood would be durable, provided it was kept saturated.

A. F. Robinson (Santa Fe): I would like to suggest that you make that first line read "the tub shall be made of suitable pine" or "the tub shall be made of acceptable pine."

The President: The committee will accept that.

Mr. Loweth: I should like cedar put in there for the staves and fir for the bottom.

The President: The committee will accept that.

Mr. Campbell: I suggest we add to the sentence in paragraph 11, in regard to the length of plank, these words, "for all tanks having a diameter not greater than 24 feet."

The President: The committee will accept that suggestion.

The chairman suggests that the word "each" be substituted for the word "the" in the first line of paragraph 12.

Walter Loring Webb: I notice that the stave shall be of uniform width end to end, etc. That practically limits these tubs to the cylindrical style rather than the conical. Is it the intention to cut out the use of conical tubs?

Mr. Ranson: Yes.

Mr. Webb: Is that not a distinct departure from common practice?

Mr. Ranson: It is a departure from common practice of twenty years ago, but not a departure from modern practice.

O. E. Selby (C. C. C. & St. L.): I see nothing in the specification to limit the width of the staves. The tendency of the manufacturers is to make the staves as wide as they consistently can, because it makes the job cheaper, and I suggest that the limiting width of ten inches be inserted.

Mr. Ranson: I think there is not much trouble to be anticipated on that score as it is difficult to get lumber of this quality that is wider than 8 inches.

Mr. Selby: We have found there is likely to be difficulty where the width is not limited, as the manufacturers will put in staves up to 10 and 11 inches wide, and they do not give satisfactory services. It is not hard to get timber of the quality demanded in fir and yellow pine, and in cypress, up to widths of 12 inches or more.

Mr. Robinson: There is an increased cost per thousand feet, board measure, for timber over 10 inches wide, and I do not think we need to worry about the manufacturers putting in many 12-inch planks, when they can use 10 inch, at $2 per thousand feet, board measure, less cost.

C. E. Lindsay (N. Y. C. & H.): While it may be true that the conical tub is a thing of the past, many railways are still using them, and as a conical tub has the merit of taking advantage of the force of gravity in keeping the hoops from falling off entirely in the event of shrinkage, I would like to endorse the conical tub.

W. M. Camp: The same question was up before the American Railway Bridge & Building Association last October, and the sentiment expressed in the discussion there seemed to conform to the committee's report, that cylindrical tubs are now preferable, since adjustable hoops have come into service. In former years, when solid hoops were used and had to be driven down, of course it was desirable to have the conical shape of tub.

(The secretary read Section 13, Tub Hoops.)

Mr. Brooke: I suggest that the last paragraph of Section 13, reading, "Each hoop shall be in three equal sections," be combined with the first paragraph, which would then read: "The tub hoops shall be half-oval, half-round, or round, and shall be in three equal sections."

Mr. Campbell: There has been some question raised as to the advisability of having three joints in the hoop. I suggest we change it to read: "Each hoop shall be in not more than three sections," and we will accept the suggestion and change the reading.

Mr. Courtenay: If this association is to go on record as abandoning the flat hoop, I think it would be desirable to go the whole length, to the round hoop. I am not able to see the advantage of a half oval or half round hoop as against a round hoop. The round has the simpler form of the three, it is generally easier to get, and I am unable to see any advantage which the half round has over the round. I think to some extent the half round would offer some of the disadvantages of the flat hoop; that is, it would rust speedily on the flat side in contact with the tub. That has been the overwhelming objection to the flat hoop. I have known of many cases of failures of the flat hoop, where the outside of the hoop appeared to be sound. If we are to change to some form of approximately round, it seems to me it would be better to adopt the round and leave out the half oval and half round.

Mr. Campbell: There is the objection to making one specification for round hoop that shall limit the recommendation to one thing. The committee believes the half oval or half round hoop is a decided improvement over the flat hoop, on account of the greater concentration of the metal and smaller surface exposed to corrosion, and in the preparation of the specifications the committee endeavored to avoid mentioning any one specific article, where we could avoid doing so, particularly where other equally good forms could be included.

Mr. Snow: I seriously object to limiting this to a round hoop on account of the trouble arising from dust and dirt collecting above the round hoop, and moisture on the outside of the stave. It might be supposed that you could keep the hoop filled with paint, but the hoop will drop away from the paint and you will have a groove there and it will rot the stave.

Mr. Lindsay: Is there anything about the round hoop or oval hoop that requires three adjusting points? We have been able to maintain tanks successfully and economically with one adjustment, both on round hoops and flat hoops.

Mr. Ranson: The only object in having a large number of joints is that we believe the tension can be more evenly distributed on the staves, giving a tighter and better tank.

Mr. Kittredge: I do not like to see flat hoops ruled out altogether. It is entirely possible that by getting a proper quality of metal, either pure iron or something that approaches it, we can get flat hoops that will give us good service. These specifications should be broad and cover all good practice. I thoroughly agree that if the hoop is made of steel, the flat hoops would probably better be ruled out, but I don't like to see them ruled out under all conditions.

Mr. Smith: I would like to know if any members of the association have had experience in the use of flat hoops of a sufficient thickness to indicate what would happen if a thick hoop were used. It seems to me the flat hoops have been condemned on account of failures that have occurred in hoops ⅛ in. and 3-16 in. thick.

Mr. Courtenay: We have used square hoops. One objection to a square hoop is that in putting it on it is hard to keep it from turning, so that one of the corners cuts into the wood. We have a round hoop on a tank that has been in since 1886. Our experience has been that staves do not rot any more quickly when in contact with round hoops than at other places. It is a bad proposition to make a good joint with a wide, thin, flat hoop. I have had tests made with several forms of friction joints in different ways, and none of them that we have tested will develop the strength of the hoop. It is an easy matter to make a good connection with a round hoop.

Mr. Ranson: The committee would like to quote from correspondence with the inspection department of the Associated Factory Mutual Fire Insurance Companies, who have made a specification for wooden tanks for use on tops of buildings in connection with fire protection.

"The strength of a tank depends chiefly on its hoops. Experience shows that flat hoops, especially those of steel, rust from the back side, where they bear against the staves, and serious accidents have happened by hoops bursting on account of this unobserved corrosion. Sometimes galvanizing or painting is depended upon to prevent rusting, but there is always the possibility that spots of the protective coating will be knocked off in handling, and one spot left unprotected may result in the failure of the hoop. Round hoops are, therefore, advised for all tanks, since, for a given cross section of metal, these hoops have the advantage of presenting the least surface to corrosion. Nearly the whole surface can, moreover, be examined or painted while the hoops are in place. In setting up a tank with round hoops there is little probability of tightening the hoops to such an extent that when the tank swells the hoops will burst; for the round hoops will simply indent the wood more as the tank swells, and the strain in the hoops is not likely to be increased to the breaking point."

Mr. Kittredge: I move that this article be so modified that it will permit the use of flat hoops.

Mr. Selby: Our road has had experience with flat hoops about twice the thickness of the average manufacturer's standard, running from ¼ in. to ⅜ in. and in width from 4 in. up to 6. Of course these hoops are stronger, and last longer, resist corrosion longer than the thin hoops ordinarily used, but we have abandoned them for round hoops. Mr. Kittredge suggests that the objection to flat hoops may be overcome by the use of some rust resisting material, ingot iron or some material of that kind. The rapid corrosion is only one of the objections to flat hoops; the other is the difficulty in making proper connection with the lug and the unsatisfactory performance of the connections after they are installed. There is a tendency to pull the hoop away from the tub at the heel of the lug. The connection to the lug is necessarily eccentric, and the pull on the draw bolts tends to pull the hoop away and bend it immediately at the heel of the lug. This makes a weak point in the hoop, and makes a point where decay can start in the staves under the hoop.

Mr. Kittredge: I objected to flat hoops exclusively a year or two ago, and I object just as much to-day to the round hoops or oval hoops exclusively. I am in favor of round hoops, but I do not want to see specifications of this association leave out flat hoops. I am sure the design and structure of a flat hoop can be so worked out that it will be efficacious. I have known flat hoops to last the life of a tank. If the flat hoops are included the clause which says they may be made of steel will probably have to be modified, as well as the remarks about the flat hoops. There is a large number of flat hoops in use in this country, and we don't want it to be understood that there are no good flat hoops.

Mr. Stephens: I have known flat hoops three-eighths inch thick protected by two coats of red lead and placed on the painted surface of the tub, to be corroded through and burst off in less than eight years.

F. H. Falkinburg (B. & O.): We have found that using the round hoops, the space at the bottom of the tub, between the hoops, being greater than the width of the hoops, it is possible to renew the hoops on an old tank by beginning at the bottom, which cannot be done where flat hoops are used, because flat hoops are wider than the spaces between them.

Mr. McDonald: I think the province and object of our association is to find out what is the best thing. Although I recall an instance of a red cedar tub with flat hoops that has stood forty years, I recall a great many other instances where flat hoops have failed that have been on only seven or eight years, and I think we ought to go on record as favoring round hoops.

Mr. Loweth: Although it is the practice of the St. Paul road, and has been for some time, to use round hoops, I think we ought not commit ourselves to one line of action. The committee has done its work with a great deal of painstaking care, and has turned in an admirable report, but I think in a measure we are putting the cart before the horse. It would be much better, I think, if this committee—and I use "this committee" as an illustration of a genral propositon—had come in with a report giving the reasons for and against these various things that are stated in these specifications, and this convention could very profitably have considered such a report. Let us have all the information in favor of the flat hoop, in favor of the other kinds of hoop, in favor of iron hoops, in favor of steel hoops, and all the other details that enter into a tank, and after that has been threshed out, perhaps we can agree on a specification. We have a great deal of discussion now because the committee asks—and properly, in view of our past practice—that these specifications be adopted. While it brings in a great deal of valuable discussion, it would be much better if these specifications were accepted as information. It seems to me this body of men can be relied on, if the information is furnished, to make their own specifications. We spend a great deal of time haggling over specifications that each one of us can settle for ourselves. Our committee work is largely in the nature of getting information, compiling it and getting data and the experience of others, and not in formulating hard and fast specifications. I think our work should stand for a great deal more than that.

The motion to include flat hoops was put to a vote and was defeated.

Mr. Snow: Will the committee agree to omit the specifications for iron? It is impossible to obtain this except from one or two concerns.

Mr. Ranson: The committee is not willing to accept that, as iron of this character can be purchased at the present time.

Mr. Courtenay: As a matter of information, I would like the committee to inform the association who does manufacture this quality of iron.

Mr. Ranson: The American Rolling Mill Company, Middletown, Ohio.

Mr. Tinker: I would like to say that there are a great many mills in the country that manufacture that quality of iron.

Mr. Campbell: It seems as if it were entirely practicable to produce this quality of iron, and if the association calls for that quality of iron, we will get it. I fail to see the force of the objection to including this specification for iron in these specifications, provided the specification itself is all right.

Mr. Brooke: I would like to state that the Baltimore & Ohio purchased a number of tanks last spring and had no great difficulty in getting wrought iron hoops.

Mr. Loweth: Why is asphaltum better than paint for coating tank hoops? It is harder to get and much harder to apply, according to this specification. I am not satisfied that it will preserve the hoop any longer.

Mr. Campbell: Probably the specification might be improved in that particular. I believe the committee is not wedded to asphaltum. I think coal tar might be all right, and there are paints which might be good substitutes for the material specified here.

Mr. Coburn: Speaking about pure asphaltum, the nomenclature of asphalt is a rather indefinite matter. Pure asphalt, as I understand it, is an asphalt with a considerable portion of oil. That is rather misleading.

Mr. Ranson: The committee would accept the suggestion and add a sentence to the paragraph saying "or such other coating as the engineer shall approve," leaving it open to coat the hoop in any manner the engineer sees fit.

Mr. Loweth: If paint is added last, it would seem that asphalt coating is preferred to paint. We have a good many steel and iron structures that are painted, and if paint is good for those, why is not paint good for iron hoops on a tank? We don't want paint last, as though it were something we might use, but ought to use the other.

Mr. Campbell: It has been my experience that the coating that adheres most closely to the iron is the coating that is placed there when both the material and the iron are hot. By heating the steel and immersing it in a bath of asphalt it gives a coating that adheres tenaciously to the material, and in that way I believe it is much superior to applying cold paint to cold iron.

Mr. Steffens: In case of bridge iron or other structures, the surfaces are accessible very largely. The back of a hoop is inaccessible and protected from the air. The moisture conditions, and the hoop that is in contact with the wood, which is to a large extent porous, must eventually break down the oxygen from the linseed oil. The asphaltum recommended by the committee has been known to stand, under such circumstances, over forty years. I hope the recommendation of the committee will stand as to the asphaltum coating and that we will not permit the linseed oil paints to be introduced.

The President: The amendment to the clause is the insertion of the words, "or such other coating as the engineer shall approve."

Mr. Loweth: Will it be implied that any other coating will have to be applied to the hoop by dipping or immersion? There are two requirements in the specification. One is that coating shall be asphalt and the other is that it shall be applied by dipping into a hot mixture. What you add should not require it to be dipped in paint, but permit paint to be applied with a brush.

The President: The committee will accept that suggestion and insert the words, "the application of such other coating." The clause will then read: "Each hoop shall be cleaned (preferably at the factory) of dirt, rust and scale, and in that condition shall be heated to 300 degrees Fahrenheit, and be dipped in pure asphalt, or the application of such other coating as the engineer shall approve." The clause will be amended in that form.

Mr. Smith: Clause 13 says, "the tub hoops shall be half-oval or half-round," and Clause 15 says, "they shall have round thread ends." How does the committee propose to make the transition from the half-oval to half-round ends? It will conflict with our steel bridge specifications, which do not permit steel welding, if the hoops are of steel and the joint is welded.

Mr. Ranson: Paragraph 15 should be changed to read, "round hoops shall have round thread ends, passing through Jugs. The joints used on half-round hoops and all others shall be as designed or selected by the engineer."

(The secretary then read Par. 17.)

Mr. Loweth: Why is it preferable to require upset ends in paragraph 17?

Mr. Campbell: An unnecessary amount of metal would be used if the ends were not upset. The strength of the rod would be limited by the strength of the metai under the thread, and these hoops are quite long. It makes a very material difference in the weight of the metal.

Mr. Loweth: At the same time I contend that for these small rods, the upsetting would cost more than the extra metal.

Mr. Campbell: The specifications say the rods should be preferably upset, but it was left to the individuals of the association to use either one.

Mr. Loweth: I move that we omit the last two lines of article 17.

The President: The last two lines will be omitted.

Mr. Lindsay: I would like to know what particular virtue the dome roof has. It does not appeal to me from an esthetic standpoint, and I cannot see any economy in it. It is difficult to make and difficult to maintain.

Mr. Campbell: The committee believes that the form of roof shown is simple and economical, as much so as any other form of roof, and probably more easily constructed than the more ordinary forms of roof. The specifications leave the description of the form of roof optional.

Mr. Lindsay: Will the committee substitute the word "will" for "shall" in the first line?

The President: That is acceptable to the committee.

Mr. Loweth: I agree that this form of roof is quite satisfactory. I think it will look well, and cost but a trifle more than the ordinary cone roof, but I would like to know why we should say the dome roof is preferable to anything else. I move that the word "preferable" be stricken out.

The President: The committee suggests the use of the word "may" instead of "shall."

Mr. Shurtleff: It seems to me that instead of going into specifications, our specifications are going into designs which will be covered by plans. I move that the paragraph be stricken out entirely and that a new paragraph be provided specifying that the roof shall be according to standard plans, which will cover the details, but the plans should not be specified in the specifications.

Mr. Campbell: On that basis we could make our specifications very short. We could simply say: "The tanks should be built according to the plans."

Mr. Loweth: Has the committee any information as to the number of railways that have built this form of roof? The committee comes and asks the association to adopt specifications in which it is stated that this type of roof is preferable. I do not know of any considerable number of roads anywhere that have been using this type of roof.

Mr. Ranson: Two years ago we attempted to get standard plans of tanks from the railways of the country. We received many answers to our inquiry, which indicated that the bulk of the railways apparently have considered the question of tank design a secondary matter, and paid very little attention to it.

Robert Ferriday: If the consensus of opinion in the association is that this form is not desirable, we would like some pretty full discussion, so that some form may be decided on in the convention here, that could be shown in our plans.

Hunter McDonald: I believe we have reached a point in the conduct of the affairs of this association when we should lay down a principle on which our work should be prepared in the future. Every time plans are presented there is continual objection, and we have never succeeded in introducing a set of plans into our manual. If we are making a mistake in instructing our committees to bring in definite specifications and recommendations, then the association should so express itself. Last year, when this question came up, the committee presented detailed specifications, and the criticism was that they were not in sufficient detail, and it was instructed to again take up the subject and bring in specific recommendations. The committee has followed the instructions in the report it has presented at this convention. If this is wrong practice, our committees in the future, it seems to me, should be instructed to bring in only the underlying principles and leave the sketches out. I believe our convention should express itself on that theory so that our work may be properly arranged for the future, and we may not be called upon to consume the time of the convention in discussing this question of design, which is constantly meeting with opposition on account of varying standards on the different roads.

The President: Mr. McDonald's remarks are very opportune. I believe it is the province of the board of direction to lay down in its instructions to the committees some specific rules of procedure.

J. B. Jenkins (B. & O.): It seems to me it might be well for this convention to request the board of direction to draw up a preamble or preface to our manual, which would state in effect that the practice recommended in the manual is considered good practice, but that it does not exclude any other methods or plans or specifications which may arrive at the desired result.

The President: For the information of the association, I will state that the board has practically agreed on such a rule, which will appeal in the new manual.

The motion to strike out clause 18 was put to vote and lost.

The President: Paragraph 18 will be amended to read: "the roof may be built," etc. It will be necessary then to amend 19, 20, 21, 22 and 23 to conform to 18. These paragraphs will be referred to the committee for amendments.

Mr. Lindsay: Does paragraph 25 confine us to the particular type of frost proofing described? There are other forms much more economical in material and as satisfactory.

P. C. Newbegin: I do not think this frost proofing as shown, would answer for a very cold climate. Up in northeastern Maine, we have temperatures down to 40 degrees below zero, and the only way we found we can keep our tanks free from ice, is to enclose the entire bottom of the

tank and put in a stove, and run a pipe from the stove through the water in the tank and keep a fire continually in the stove.

Mr. Lloyd: I was brought up in the northwest, where they have as cold weather as in Maine, and we arranged our frost proofing in the same way as outlined in the report. We did not find it necessary to have a stove.

Mr. Loweth: I ask the committee if it is always necessary to have the water supply pipes and the discharge pipes separate? There are many cases where the two can be combined in one. This design is prefaced with the statement that the tank is designed to deliver water to locomotive through water columns. I think the practice is to separate the two pipes.

Mr. Lindsay: Our experience recently has been that the floating valve can be very much improved by the use of an automatic valve in the frost pit. The floating valve in places where you are troubled with considerable ice, is very often frozen up, and does not indicate the continuity of the supply. While I judge the specification does not prohibit the use of such a device, I call it to the attention of the association. There is also an improvement that can be made in the elbow in the frost pit, at the base of the supply pipe, where the supply pipe rises to supply the tank. If this is made a T instead of an elbow, and provided with a plug, the sediment which gathers at the foot of the supply pipe, and interferes with the supply can be blown out.

Mr. Loweth: I wish to take exception to the chairman's statement that the best practice involves the use of two pipes. That is not always true. There are times when money is saved by putting in one pipe, and letting it serve both purposes.

Mr. Lindsay: Referring to paragraph 28, a sludge hole in the bottom of the tank is a very dirty and uneconomical arrangement. When you open the hole and let the sludge out, it goes all over the substructure, and you must wash, or repaint it. There should be a pipe from the sludge hole to a suitable point on the ground. I think the sludge hole should be equipped with a better device than a plug of wood. There should be a recessed cast iron cap that could be put on the hole and tightened down so as to prevent leakage.

Mr. Lindsay: The definitions in paragraph 33, should appear in paragraph 1.

The President: The committee accepts the suggestion.

Mr. Wendt: The association is now twelve years old and there is a very sharp difference of opinion as to whether a manual should be published or not. There is also a very decided difference of opinion as to what should enter into the manual. I believe we have reached a point where the manual should contain less subject matter. The original purpose in publishing a manual probably has never been stated. I do not know what that original purpose was, except as we find on the index page of the manual, but it is my personal opinion that the greatest value of the manual should lie in the fact that it contains these general specifications, which will enable railways to obtain competition in the purchase of materials. It should contain well defined principles which could be followed by engineers generally.

It may or may not be desirable to introduce standard plans in the manual, but I think it is quite out of the question to introduce into the manual standard designs of structures. We have reached the point where it would be fair to lay down the general principles that committees may well prepare standard plans, not with the object of having them adopted as parts of the manual, but for the purpose of having them approved as information, as to best designs suitable to definitely prescribed conditions. I move that the report of this committee on specifications for wooden water tanks be received as information.

The motion was carried.

After some discussion as to the time available for considering the report of the committee, a motion that the report be received as information was carried.

WOOD PRESERVATION.

The following sub-committees were appointed:

Revision of Manual: Octave Chanute, chairman; V. K. Hendricks, G. M. Davidson, Walter Buehler.

On Specifications for New Processes: V. K. Hendricks, chairman; A. L. Kuehn, E. H. Bowser, G. E. Rex, W. Buehler, E. Stimson, H. F. Weiss.

On Grouping: H. F. Weiss, chairman; Octave Chanute, E. A. Sterling, A. L. Kuehn.

On Specifications for Timber and Piling: Hermann Von Schrenk, chairman; L. Bush, W. H. Courtenay, W. K. Hatt.

On Statistics: Octave Chanute, chairman; W. H. Courtenay, E. A. Sterling.

On Track Scales for Weighing Ties: Hermann Von Schrenk, chairman; Earl Stimson.

REVISION OF MANUAL.

Certain changes have been recommended in the specifications for creosote oil, which are summarized as follows:

Paragraph 1. The definition of creosote oil restricts its origin to coal tar, and allows an admixture of refined coal tar to the creosote oil.

Paragraph 2. Fixes the per cent. of insoluble matter at 2 per cent. This is necessary to control the amount of free carbon in the oil when coal tar is added thereto.

Paragraph 3. Places an upper limit of 1.10 on the specific gravity. This limit is placed arbitrarily, for as the gravity of oil for paving blocks has been fixed at from 1.10 to 1.15, it would seem that the oil for treatment of ties and timbers should not have any higher gravity than the paving block oil.

In paragraph 5 it is specified that the fraction between 210° and 255° C. shall deposit naphthalene salts on cooling, and the fraction between 315° and 355° C. shall yield solids on cooling. The demand that the oil shall not show any evidence of decomposition as indicated by the presence of dense white fumes in the condenser is intended to guard against adulteration from water-gas tar.

The committee recommends an additional paragraph to the recommended practice providing for accurate tests of

W. K. Hatt.

Chairman, Committee on Wood Preservation.

the life of ties, in an especially selected and carefully inspected test track. While it is thought that the use of the dating nail in each tie is justified by its educative value to trackmen and others, yet the accurate determination of the relative life of ties, and their behavior under service, demands a more careful supervision at the hands of trained assistants than is possible under the present system.

The sub-committee for piles and timber to be treated proposes an addition to recommended practice providing for the framing of timbers before treatment.

SPECIFICATIONS FOR NEW PROCESSES.

The sub-committee on specifications for new processes reports that it is impracticable to write specifications for patented processes. They have, therefore, obtained from the persons in control of such processes an accurate description of the method of conducting them.

GROUPING.

The sub-committee on grouping presents a progress report.

SPECIFICATIONS FOR PILES AND TIMBER TO BE TREATED.

The sub-committee presents a draft of such specifications for discussion. The present standard specifications of the association have been followed, as far as possible, except that sap restrictions have been removed. With the endeavor to call the attention of the mill men to the desire of the consumer to obtain material with a large amount of

sap, rather than all heart pieces, the statement is made in the specifications that sap wood is to be preferred. The reasonable exception is that this change would operate to reduce the cost of material.

TRACK SCALES FOR WEIGHING TIES.

The specifications adopted last year for tie treatment provided for the occasional weighing of buggy loads, in and out of the cylinder. The subject of track scales has been investigated by the sub-committee, which finds that track scales for weighing ties are now being used occasionally in treating plants in this country and quite generally in Europe. It recommends that a track scale be installed at every treating plant wherever possible.

STRENGTH OF TIES TREATED WITH CRUDE OIL.

Last year's report on Strength of Treated Timber mentioned certain tests of ties treated with crude oil. Subsequent tests on the same ties show that the temporary softening of the surface had disappeared upon exposure, but that the reduction of the spike-holding power in the treated ties still remains.

ELECTRICAL CONDUCTIVITY OF TREATED TIES.

The committee presented the results of investigation of the passage of electrical current through treated and untreated ties of various species.

CONCLUSIONS.

(1) That the revised specifications for creosote oil be adopted for publication in the Manual.

(2) That the two paragraphs recommending the selection of a section of track for testing the life of ties, and recommending the framing of timbers before treatment be added to the recommended practice of the association.

The report is signed by: W. K. Hatt, Purdue University, chairman; W. H. Courtenay, L. & N., vice-chairman; E. H. Bowser, I. C.; Walter Buehler, Kettle River Company; Lincoln Bush, Consulting Engineer; G. M. Davidson, C. & N. W.; George E. Rex, A. T. & S. F.; V. K. Hendricks, St. L. & S. F.; A. L. Kuehn, American Creosoting Company; E. A. Sterling, Pennsylvania; Earl Stimson, B. & O.; Hermann von Schrenk, R. I.; Howard F. Weiss, United States Department of Agriculture, committee.

APPENDIX H.

The Electrical Resistance of Timber as Affected by Treatment with Preservatives.

An investigation to determine the resistance of ties as affected by treatment with preservatives was made by Mr. J. T. Butterfield, of the School of Electrical Engineering at Purdue University, in the spring of 1910.

The material available for the tests consisted of four shipments of ties. The specimens tested vary in size from half a tie to a small section cut from half a tie.

The resistance was measured by the method commonly used for measuring the insulation resistance of electrical machinery, namely, by means of a direct current voltmeter of known resistance. This method was applied in two ways: (1) The contact surface for flow of current in the ties was a sawn surface as nearly plane as possible. Contact pressure of 250 lbs. per sq. in. was applied in a Riehle testing machine by means of sheet-iron pans, placed one above the other and filled between with dry sand, by which constant surface resistance was obtained. (2) After some of the fundamental laws were investigated, the resistance of the various ties was compared by measuring the current flowing between two spikes driven 20 in. apart in the face of each tie. Then the relation of these latter tests, between the two spikes, to the conditions obtaining in a full tie with rails spiked thereto was investigated.

In beginning the tests the principal elements which cause the resistance to vary were determined and investigated in the following order:

(1) Amount of moisture present. (2) Kind of wood. (3) Treatment. (4) Direction of grain. (5) Contact pressure. (6) Temperature. (7) Amount and time of current flowing. (8) Dimensions of specimen.

The results obtained tend to establish the following conclusions:

Timber is ordinarily classed with the non-conductors. When dry and well seasoned, it has a very high dielectric strength and practically infinite resistance. When green or moist, however, timber becomes a kind of electrolytic conductor of comparatively low resistance. The treatment with zinc preservatives has the simple effect of producing in the wood a stronger electrolyte and hence a better conductor of current.

(1) The resistance of timber varies directly with the length and inversely with the cross section.

(2) The resistance of timber varies almost inversely with the amount of moisture present, between the limits of 15 and 50 per cent.

(3) The resistance of timber is lowest when measured along the grain, and highest when measured tangentially to the growth rings.

(4) When treated with a soluble salt such as zinc chloride, the resistance varies approximately inversely as the amount of the salt present.

(5) Treatment with such a soluble salt does not change the behavior of the resistance with respect to the per cent. moisture present. Only the amount of the resistance is changed.

(6) The resistance of timber varies almost inversely with the temperature between the limits of zero and 30 degrees Centigrade.

(7) The resistance of non-porous woods, such as the pines, is higher than that of porous woods, such as the oaks and red gum.

(8) Treatment of timber by different creosote processes does not greatly change the natural resistance of the timber.

(9) Finally, all the data taken go to establish the view that the conductivity of wood is due primarily to the presence in the pores of an electrolyte formed by an aqueous solution of the salts found in the natural timber, or of these salts and others artificially introduced.

Assuming the worst condition for leakage covered by the test, i. e., red oak ties treated with zinc chloride laid in wet ballast and with wet rail bearings, the resistance between the rails of a block one mile in length would approximate 30 ohms. This would permit a leakage current of .05 ampere to flow with the battery voltage of 1.5 volts. The leakage loss would, therefore, be .075 watt, or about 30 per cent. of the power required to operate the relay. This should not seriously interfere with the operation of signals, as leakages up to 60 per cent. exist without such serious interference.

It is to be regretted that determinations of resistance were not made with wet ties or with ties and rails partially immersed in water, as is sometimes the case in practice, for it is believed that under such conditions the leakage current would probably be sufficiently large to interfere with the successful operation of relays.

As a final conclusion, it should be noted that since the above results show only a reduction in resistance of a tie of from 26 to 53 per cent. when treated with zinc chloride, depending upon the percentage of moisture, while a change of resistance by the ratio of 25 to 1 may be effected by varying the kind of wood, a change of 33 to 1 by varying the pressure upon the tie sufficiently, and of 3.7 to 1 by temperature changes, it follows that the treatment of ties with preservatives should not interfere with the operation of signal circuits, except possibly in exceptional cases in which the resistance of the leakage paths is abnormally low from other causes.

Discussion on Wood Preservation.

Mr. Courtenay: The committee requests that no consideration be given to conclusion (1), 'That the revised specification for creosote oil be adopted for publication in the manual," and that the association refer that conclusion back to the committee for future consideration. The committee would also desire to withdraw from the consideration of the association Appendix A.

The President: The committee is willing under conclusion (2) that the recommendation with reference to the selection of track for testing the life of ties be submitted to the board of direction for its action. The recommendation of the committee in conclusion No. 2 that the framing of timbers before treatment be added to the recommended practice of the association is open for discussion.

C. E. Smith (Mo. Pac.): It is not practicable in all cases to frame the timbers, including the boring of holes, before treatment. Take, for example, a cap on a pile. It would not be practicable to bore the hole in connection with the sway brace before it was put on. It would not be practicable to bore the holes for the chord bolt through the stringers. I think the committee should specify a treatment for such timber as must be worked in the field after the timbers have been treated.

Mr. Courtenay: The only thing that can be done is to mop

such surfaces with creosote oil, which is a very simple process.

Mr. McDonald: Where it is necessary to bore holes in timber after they have been treated, if the holes are vertical, they should be plugged, and filled with creosote, and the creosote allowed to soak in. Where it is necessary to frame small timbers which can be handled, it will be found the best treatment to immerse the frame end in hot creosote, permitting it to remain for about twenty minutes, taking it out, and immersing it in cold creosote, and permitting it to remain a similar length of time. That cannot be done where you saw off the end of piles, nor in the case of large timbers. Something better than mopping should be insisted upon, if it is possible to do so.

Mr. Courtenay: The Louisville and Nashville has been using creosoted timber in its trestle structures on a considerable scale since 1876. For that reason, our bridge supervisors have accumulated a great deal of experience with this material. We have adopted various expedients and endeavored so far as possible to frame creosoted material before it is creosoted, and have gone to the length of taking green timber, framing it, regularly erecting it in the structure, to insure a fit, and then taking it down to creosote it. After a long observation in the use of creosoted bridge timber, we find that with good hard yellow pine, it is almost impenetrable, that we can hardly get a penetration of the creosote of one quarter inch. We have creosoted timber in these structures which has been there since 1876, and is apparently very good today. We have tried mopping with hot creosote oil, and have endeavored to get information concerning it from our supervisors of bridges and buildings over about fifteen divisions. There is a difference of opinion as to whether it is effective. It is the best thing we have been able to devise at reasonable cost.

Mr. Smith: I do not think this association should express its approval of putting frame timbers in a structure and then taking them out and shipping them to some point for treatment, and I trust the committee will amplify this portion of the subject by giving some method of treatment in the field.

C. F. W. Felt, (Santa Fe): On the Galveston viaduct, we used a marine treatment. We have no trouble with decay on that bridge. We used the 24 pound per cubic foot treatment. It is our rule to mop the timbers with hot creosote, and also with asphalt on the ordinary ballast deck construction.

Mr. Courtenay: In 1882, a pier was constructed at Pensacola, Fla. Alongside of that pier, at every opening, there were a number of mooring piles standing high above the pier. The tops of the piles were exposed to the sun. They were necessarily cut off to the proper height above the top of the pier. The tops of the piles were mopped with creosote oil and in addition had a thick covering of hot pitch with some lime mixed with it. In 1887, the heart wood in the tops of a number of these mooring piles was so rotten that a man could pick out a conical shape plug with his fingers. Other piles lasted much better. Nearly all of them are exposed to the rays of the sun. When a pile is creosoted, and driven, and you cut off the top of the pile to get proper bearing for the cap, the top of the pile under these conditions does not rot. We had creosoted timber, heart pine, put in trestle structure between Mobile and New Orleans and covered with two feet of sand, put there in 1886, and the timber is good today, and as far as I know, they are the first ballast deck trusses of creosoted wood put in such a manner as to be protected from the action of the sun and to avoid the exposure of the creosoted portion. Our experience is that pick holes in the sides of the piles will not hurt them much, but if a man scrapes along the sides of the piles, in order to make the bracing fit better, he is ruining his material.

W. F. Goltra: The demand for a speedier and more efficient method of kiln drying or seasoning ties is well known to those who have given that subject any attention. The seasoning of ties in the open air is slow and unsatisfactory. They can be artificially dried at much less expense and very much quicker than they can by open air seasoning. Ties or timber have to be dry, before they can be treated, and it has been the custom of railways and some manufacturers who use wood for implements for furniture, etc., to stack the material in the open air. The ties can be dried artificially at an expense of only 1¼ cents each for fuel. That is less than the interest on the capital which is held up by ties stacked in the open air for seasoning, and is much less than the deterioration of the ties which takes place while they are seasoning. Should not this committee be instructed to investigate the kiln drying of ties or timber versus the open air seasoning?

BUILDINGS.

The following sub-committees were appointed:

Roof Coverings: Maurice Coburn, chairman, H. M. Cryder, C. H. Fake, P. F. Gentine, H. Rettinghouse, C. W. Richey.

Tool Houses: William T. Dorrance, chairman, George W. Andrews, J. P. Canty, D. R. Collin, M. A. Long.

Reinforced Concrete Coaling Stations: E. N. Layfield, chairman, John S. Metcalf, O. P. Chamberlain.

REVISION OF MANUAL.

The committee recommends no further revision.

REINFORCED CONCRETE COALING STATIONS.

A number of reinforced concrete coaling stations have been built since the report of last year, notably one by the Philadelphia & Reading at Philadelphia, with a capacity for handling 700 tons of coal per day of 10 hours and with a storage capacity of 2,000 tons.

The committee has no further report to make, but desires to have the subject referred back to it for the purpose of noting and reporting on the operation of the stations already built and the progress in designing new ones.

TOOL HOUSES.

The committee reports progress on the subject of tool houses.

BITUMINOUS ROOFING MATERIALS.

Information concerning the relative value of the bituminous materials for roofing is not easily available. The detailed knowledge held by the leading concerns preparing the materials has been acquired by expensive experience and is regarded as a valuable asset not to be shared by possible competitors and the ignorant purchaser.

O. P. Chamberlain.

Chairman, Committee on Buildings.

The bitumens are compounds of many different hydrocarbons with different chemical formulæ and widely-varying melting points. They are always accompanied by greater or less amounts of impurities, and are obtained either naturally or as the heavier distillates or residues of coal, petroleum or other organic substances. Their distinguishing characteristics are their elasticity and binding power or adhesiveness, their considerable immunity from action by water and their solubility in oils and certain other organic compounds.

Asphalt.—The term asphalt is ordinarily considered as referring to bitumens found naturally in the solid state and will be so used in this discussion.

The asphalts are generally stable in the atmosphere. As found naturally, they are not commercially available, even after the impurities are removed, being too hard and brittle for most purposes. This is ordinarily remedied by softening or fluxing with various oils, an operation requiring skill. The character of the fluxes has a most important effect upon the finished product. Petroleum products are ordinarily depended on for this purpose. The fluxes should be sufficiently stable to insure against too rapid hardening of the fluxed asphalt. They should be free from deleterious constituents and should be of such a character that they will combine with the asphalt to be fluxed so as to make a homogeneous and per-

fect solution. Certain fluxes which work well with certain asphalts are not at all suitable for use with other asphalts. Poor results are sometimes supposed to be due either to chemical action in the fluxes or to chemical action between the fluxes and the asphalts. Tars are sometimes employed for fluxing purposes, but they do not mix easily with the asphalt. As asphaltic compounds age they tend to become brittle and hard, losing their elasticity and binding power. Poor fluxes hasten this process.

TARS.

Coal Tar.—From the distillation of bituminous coal, either in a plant for the production of illuminating gas or in a by-product coke oven the products may be roughly divided into four classes, the gas, the ammoniacal liquor which is the scrubbing water with the materials which it has absorbed from the distillates and which it holds in solution, the coal-tar, a heavy liquid containing the distillates insoluble in water which have settled away from the ammoniacal liquor and the coke.

The coal-tar contains some water, various impurities, and free carbon which after the water has been removed, is ordinarily from five to thirty-five per cent of the total. This is carbon formed by the cracking of the hydrocarbons and is in a very finely divided condition. The percentage varies with the method of manufacture. The distillates or bitumen are composed of hydrocarbons which have widely-varying melting points, and degrees of volatility. These may be roughly classified into light oils, creosotes and pitches. The character of the tar varies with the coal used and the manner in which the process is carried on. The greater the heat, the more the hydrocarbons are cracked into their constituents and the greater the amount of free carbon and of gas found and the less the amount of coal-tar. The question of the relation between the free carbon and coal-tar is one of considerable importance. It is generally considered to be a valuable adjunct to roofing tars and pitches. Free carbon makes the material less affected by changes in temperature. Comparing two pitches of similar consistency at normal temperatures the one having the greater amount of free carbon must have to neutralize it a greater per cent of the lighter, more elastic and to some extent more volatile hydrocarbons and less of the heavy ditches. When it is cold the pitch is less brittle and when it is hot does not flow so readily because of the carbon present. Thus a tar of a given consistency may notwithstanding the fact that it contains large quantities of an inert material apparently have more life than another with less of the free carbon.

When coal-tar pitch is exposed to the weather there is found upon its surface a thin layer, hard and brittle, the residue after the drying out of the volatile oils. This acts as a sort of protective coating to what is underneath. As soon as it is disturbed, exposing fresh pitch, the process is repeated. High carbon tars seem to weather better than low carbon tars, the increased amounts of free carbon seeming to aid in the foundation of the skin or protective coating.

Watergas Tar.—Watergas is made by passing steam over hot coke or anthracite coal, which decomposing the steam, forms carbon monoxide and hydrogen. This does not possess sufficient illuminating power, and to enrich it, there is added a gas produced from petroleum which leaves a tar often used in place of coal-tar. In the process which it undergoes the oil residues are so changed by the high heat as to lose many of their characteristics and to acquire some of those of the compounds found in coal-tar. Compared with coal-tar, its oils have less antiseptic properties. As obtained from the gas manufacturers it is thinner, containing more water, more light oils and less of the pitches and no free carbon. It is distilled down and treated much as is coal-tar and its pitch is very similar in appearance to that of coal tar.

Watergas tar decomposes easier than coal-tar. It often contains some paraffine though ordinarily not in sufficient quantities to affect the product. The crude watergas tar is also much more affected by water and is capable to a considerable extent of forming an emulsion with it. Good coal-tar is practically unaffected by water, and it deteriorates from the surface only. Oil tar products like the oil fluxes used with asphalts are liable to undergo chemical changes which may tend to make the entire mass hard and brittle.

Not long since practically the only use of tar was for roofing and the entire supply came from the manufacture of illuminating gas from coal. The situation has been changed by the increasing supply from by-product ovens, by the manufacture of watergas in large quantities, by the great demand for creoscte oils and other by-products, by the use of coal-tar for waterproofing masonry, by its use for briquetting coal slack and by its adoption for use as a road binder as a protection against the ravages of the automobile.

With skill in compounding, based on a thorough working knowledge of the materials used, asphaltic compounds can be prepared of natural asphalts and oil residuals with valuable qualities for many different roofing needs, whose durability under known conditions can be foretold with considerable accuracy. The same can be said, perhaps with more certainty as to results, of the different tars. Either can suffer from adulteration and poor preparation. Considering first-class materials the coal-tar is cheaper, more easily affected by temperature changes, and is not acted upon by water nor is it liable to internal chemical changes.

FELTS.

The felts used with almost all bituminous roofings play a very essential part in the final product.

The desirable qualities of the felt vary with the saturating material to be used. With asphalt, saturating power is the main desideratum. For coal-tar which under heat is much more liquid, this quality is not so necessary. All must be strong enough to avoid damage in handling before saturation. The strength of the finished product is due to a great extent to the saturation.

The felts are mainly made of rag stock which is chiefly cotton rags. The best felts for saturation by asphalt rarely contain more than 25 or 35 per cent of wool, and those for use with coal-tar contain much less. As ordinarily used the term wool-felt applies to a soft felt with very little wool in it.

The methods of manufacture have a considerable effect on the quality of the material. The felt must be well beaten to avoid large lumps, which are sources of weakness. The felt is made on a machine similar to that used for making ordinary paper and variations in its operation determine the quality of the finished products.

The dry felts are sold by weight. The standard is the amount which would lay 480 sq. ft · If a felt weighs 28 lbs. to 480 sq. ft., it is known as No. 28. For this reason felts sometimes have their weight increased by the addition of a mineral filler. This is nothing more than an adulterant which intereferes with the saturating power.

Felts of asbestos are not used in one or two roofings. These are poor saturants and are more in the nature of protection to the asphalts. They will not burn or decay.

BUILT-UP ROOFS.

The main use of tar for roofing has been in the construction of built-up roofs where layers of felt saturated with tar are nailed down and by the use of a tar pitch protected and cemented together.

The following specification accompanied by the necessary diagrams give what is considered as good practice in the construction of a flat built-up roofing on wooden sheathing.

Specification for Felt, Pitch and Gravel or Slag Roofing Over Boards.

Incline.—This specification should not be used where roof incline exceeds three (3) in. to one foot. For steeper inclines modified specifications are required.

Specification.

Roofing.—First, lay one (1) thickness of sheathing paper, or unsaturated felt, weighing not less than five (5) lbs. per hundred (100) sq. ft., lapping the sheets at least one (1) in.

Second, lay two (2) plies of tarred felt, weighing fourteen (14) to sixteen (16) lbs. per hundred (100) sq. ft., lapping each seventeen (17) in. over the preceding one, and nail as often as is necessary to hold in place until remaining felt is laid.

Third, coat the entire surface uniformly with straight run coal-tar pitch.

Fourth, lay three (3) plies of tarred felt, lapping each sheet twenty-two (22) in. over the preceding one, mopping with pitch the full twenty-two (22) in. on each sheet, so that in no place shall felt touch felt. 2 Such nailing as is necessary shall be done so that all nails will be covered by not less than two (2) Plies of Felt.

Fifth, spread over the entire surface a uniform coating of pitch, into which, while hot, imbed not less than four hundred (400) lbs of gravel, or three hundred (300) lbs. of slag, to each one hundred (100) sq. ft. The gravel, or slag, shall be from one-quarter (¼) to five-eighths (⅝) in. in size, dry, and free from dirt.

Flashing.—Flashings shall be constructed as shown in detailed drawings.

Labels.—All felt and pitch shall bear the manufacturer's label.

Inspection.—The roof may be inspected before the gravel or slag is applied by cutting a slit not less than three (3) ft. long at right angles to the way the felt is laid.

N. B.—To comply with the above specifications, the ma-

terial necessary for each one hundred (100) sq. ft. of roof are approximately as follows: 100 sq. ft. sheathing paper, 80 to 90 lbs. tarred felt, 120 to 160 lbs. straight run coal-tar pitch, 400 lbs. gravel, or 300 lbs. slag.

In estimating felt, the average weight is practically fifteen (15) lbs., per one hundred (100) sq. ft., and about ten per cent (10 per cent) extra is required for laps.

In estimating pitch, the weather conditions and expertness of the workmen will affect the amount necessary for the moppings, and to properly bed gravel or slag.

In the final coating of a coal tar roof the effort is to get the maximum amount of pitch coating which can be kept in place. The flatter the roof the greater the amount of pitch that can be used and the better both pitch and gravel will stay where put. The best results are obtained when the slope of the roof is only enough to allow it to thoroughly drain. When it gets above two inches to the foot many object to its use, but the above specifications are considered by others as good practice up to three inches to the foot.

Where thorough inspection is not provided during construction the roof can be inspected by cutting a strip three feet long at right angles with the way the felt is laid before the gravel is applied. This can be readily repaired so that no damage is done to the roof.

As an indication of what can be done in territory adjacent to Chicago and St. Louis the following figures may be of interest. They show actual costs on a roof of about five hundred squares laid according to the specifications given above. The work was seventy-five miles from the gravel supply and one hundred and seventy-five miles from the headquarters of the contractor, who paid all freight and fare. This work was done close to a railroad track, so that nothing was necessary for hauling to the work. Nothing is included for overhead or fixed charges or for profit.

Cost per square:	
5 lbs. sheathing paper	$0.12
155 lbs. pitch at 60c per cwt	.93
85 lbs. felt to square at $1.40 per cwt	1.19
Nails and caps	.05
Cleats for flashing	.05
Gravel (about one-seventh of a yard	.23
Labor, including hauling, board and railroad fare	1.15
	$3.72

Plastic Roofing.—This is a sort of built-up roof used especially on steep slopes, where in place of using ordinary roofing pitch we have a compound of some fine inert substance with tar or some other bituminous material which is plastic when warm and which can be applied with a trowel. It is not extensively used and its application is mainly confined to the eastern part of the country. Except for steep slopes it has little value, as it lacks elasticity and because it requires considerable skill to get the proper proportions.

Built-Up Asphalt Roofing.—Built-up asphalt roofs have been used with considerable success. Asphalt is much less affected by temperature changes. For a roofing cement it must have considerable proportions of flux to make it easy of application. Coal-tar felts are often used with asphalt roofing cements. With asphalts, the dry sheet can ordinarily be avoided. Where first-class material is used it is ordinarily expensive and it is harder to handle. Except for steeper slopes than are suitable for coal-tar, its use is not recommended unless unusual conditions make it more economical.

Built-Up Asbestos Roofing.—There is on the market materials for a built-up asbestos and asphalt roof. The asbestos, besides its well-known fire-resisting value, has the advantage that, being mineral, it will not decay. It is not as absorbant as felt and acts more as a protection to the bitumens than as a saturant. This roofing is ordinarily applied only by the manufacturers. The fire-resisting value of the asbestos is perhaps overrated and the wearing qualities of the top layer are quetioned.

PREPARED OR READY ROOFINGS.

To compete with it and to meet some of the conditions where a built-up roof is not satisfactory or too expensive, innumerable prepared or ready roofings have been put on the market. These ordinarily come in rolls accompanied by the nails and cement necessary to apply them. They vary from a very light felt with the cheapest possible saturant and enough sand or soapstone coating to prevent sticking in the rolls, to a sheet so heavy that it cannot be rolled, built up of heavy felts and strengthening materials and saturated and protected by carefully prepartd compounds, possibly protected also by a coating of crushed stone.

The saturant should be liquid enough at workable temperatures to thoroughly impregnate the felt. The protective coating should be stable and not easily affected by the elements. The saturation of the felt is a very vital feature. This must retain its life and elasticity to keep the roofing efficient. A protective coating of material similar to the saturation is often used with the idea of helping to maintain the life of the saturating material.

The prepared roofings may be divided into two general classes—smooth and stone-surfaced. The stone-surfaced roofings are to a certain extent an adaptation of the built-uproofings. They frequently have at least two felts cemented together. The gravel or slag used must be uniform in size and finer than that available for built-up roof. The steeper the roof the more chance they have to lose their stone coating. The amount of material that can be used in the heavier brands is limited to the amount that can be successfully rolled. If the stone be too large, it may damage the felt in rolling; if too small, the amount of pitch is limited.

Tarred felts in which there are two or three plies of felts cemented together with pitch are sold ready to be laid. They must be covered with a tar coating upon laying and at frequent intervals to show any value at all.

The asbestos roofings are made to include one or more plies of asbestos felt, with possibly a jute center. They are cemented together by asphaltic cements. In the heavier brands they are expensive. The asbestos felts are poor saturants. These roofings have given promise of good results and are widely used. The asbestos will not burn, but the amount used is so small that its insulating value is not great, and the value of these roofings from the standpoint of fire protection is probably frequently over-estimated.

Burlap or jute canvas is used in ready roofings as a strengthening material. It is not a good saturant and must be kept thoroughly coated, as otherwise it goes to pieces readily. It is employed in conjunction with either felts or asbestos sheets. We question its value, feeling that better results can be obtained from a proper quantity of ordinary felt.

The use of tin caps under the head of nails to secure prepared roofing should be avoided. When used, they must be kept constantly coated to prevent the rapid disintegration of the steel plates of which they are composed. If this occurs the nail head stands clear of the roofing, which is then an easy prey to wind storms. Care should be taken in the flashing and around the edges of the roof to have it thoroughly fastened down. Nails of a No. 12 gage wire with a cap made of cold-rolled hoop steel welded on in the factory are used for this purpose. Some recommend nailing every two inches, but with large-headed nails every three inches is usually considered enough.

One of the chances for trouble with many of the ready roofings is their tendency to stretch and wrinkle and the difficulty in laying them absolutely tight and flat. As the roofing grows older and brittle the wrinkles become danger spots which are liable to crack if walked on. The roofing should be as thoroughly stretched as possible in laying. Knot holes should be covered before applying the roofing. In cold weather it is well to warm the rolls to avoid any chance of cracking.

The ready roofings usually commence to show deterioration after they have been kept in stock for three of four months. In purchasing care should be taken to avoid old material.

The ready roofings are of value for small and isolated buildings where the cost of laying a built-up roof would be excessive and for temporary structures where a roof of long life is not necessary. They can be laid without the expert help required for a built-up roof and most brands can be used on any slopes, although on flat slopes extra precautions must be taken to prevent leaking. They can be obtained at almost any desired price, but ordinarily cheaper than a good built-up coal-tar roof.

Most of the ready roofings are sold under a five or ten years' guarantee, and many contracts for built-up roofs are similarly prepared. To depend upon these guarantees alone does not give satisfactory results even though the manufacturer be financially responsible. He can expect more immediate profit by preparing a roof which he is sure will last six or seven years and selling it under a ten years' guarantee than by preparing a roof which he is sure will last for ten years. At best the life will be uncertain and with good luck a roof built for six or seven years or even less might last twice as long. If it should need extensive repairs before the guarantee runs out there is considerable chance that the manufacturer will not be called on to make the repairs, and if he is, the loss is not great. Guarantees are liable to be so worded as to afford various loopholes for avoiding expense and they should, if relied on, be carefully scrutinized. A good roofing should last much longer than any possible guarantee can provide for. If the guarantee is made good, there still may be nothing left at its expiration.

WOOD SHINGLES.

A wood shingle roof properly laid and of good material will last for many years. Good shingles can still be obtained from the Pacific Coast for a reasonable price, though not equal to the white pine formerly obtainable. The nails ordinarily corrode before good shingles have deteriorated noticeably, allowing the shingles to become loosened and displaced. If the shingles are dipped in linseed oil or creosote their life will be considerably increased. Painting after laying with a linseed oil paint induces decay and should be avoided. The main objection to shingles is their fire hazard. When the roof is old and a little out of shape, it is especially dangerous, providing a chance for the lodging of sparks. It must have a pitch of not less than six inches to the foot.

To avoid the chance of one joint coming over another, they should always be laid with at least three laps. With a 16-inch shingle not more than 4¾ inches should be exposed. There should be two and only two nails in each shingle.

SLATE.

Slate comes with considerably varying qualities. It should be hard and tough and have a well-defined vein which must not be too coarse. If too soft it will absorb moisture. If too brittle, it cannot be cut and punched without splitting, and it will easily be damaged by walking on the roof. Crystals are sometimes found which disintegrate on exposure to the weather. Acid gases in the air and freezing of absorbed water tend to cause a disintegration of the slate. A clear metallic ring when struck is an indication of soundness. A cracked or soft slate gives a muffled sound.

Slate should should not be laid on a roof having less than a one-quarter pitch, and a one-third pitch is better. When it is flatter than this it is liable to leak from capillary attraction. Finely powdered snow, driven under the slate by high winds and, later on, melting and freezing, is liable to cause damage to a slate roof. To be sure of the best results it should be laid on a good waterproof felt. In nailing slate each piece should be secured by two nails. Where exposed to gases the nails should be as far as possible non-corrosive, as they frequently determine the life of the roof.

In laying, care should be taken to avoid cracking the slate by driving nails carelessly or too tight.

TILE.

Clay roofing tile, unglazed without being hard burnt, is more or less porous and moisture is liable to cause damage in freezing weather. If glazed, the glaze, if improperly made, is liable to decompose on exposure to the elements. Properly made, good roofing tile cannot be excelled for durability. With tile, it is a little harder to get a tight roof than with slate. Interlocking shapes have been devised, giving very good results in this respect, although there is liable to be danger from driving rain or snow. Sometimes the tile is bedded in a plastic cement, but ordinarily, to be sure of the best results, it is laid on a good waterproof felt. When laid on a close wood sheathing it is held in place by battens nailed horizontally on top of the sheathing and is fastened down by wire. Copper wire, not less than No. 12 gage, could be used for this purpose. Steel wire or bands are liable to corrode.

Tiles should not be used on a roof having a pitch of less than six inches to the foot.

IRON OR STEEL ROOFINGS.

The further the material varies from pure iron the more liable it is to corrosion, and a great deal of the trouble in such roofing is due to the poor steel used, which will not last more than a few years, no matter how protected.

During the past few years a very pure iron, made by new processes has been put on the market. Laboratory tests would indicate that excellent results may be expected from this material. It is cheaper than charcoal iron, but more expensive than steel. We believe that its extensive use is justified but that it has not yet been tried in actual service long enough to warrant any positive recommendations.

Corrugated Iron or Steel.—Owing to the difficulty in getting good iron for this purpose this roofing is ordinarily avoided for railroad work. Galvanized, it does not give good results. If pure iron can be obtained, this material may be valuable for use in roofing certain buildings, such as some types of shop buildings and open umbrella shelter sheds.

Asbestos protected metal, lately introduced, is corrugated steel which is used with a bituminous coating covered with asbestos as a protection to the steel plate. This has not been in use long enough for any definite opinion to be given in regard to it.

Metal Shingles.—Metal shingles are used to some extent by different railroads. Of good material and properly protected, they have their uses.

Tin Plate.—Tin plate has a body of iron or steel. The coating is in most cases an alloy of lead and tin, with lead usually predominating. When tin is specified, the coating should consist of not less than 30 per cent. pure tin, nor more than 70 per cent. pure lead. Not less than 20 pounds of the coating should be used per box of 112 sheets 14 inches by 20 inches.

Where the coating is all of lead, it is called terne plate, and is used when cheapness is an object.

Good tin plate for roofing can still be had, and where it is desired to use this material for roof covering, one of the reliable brands of hand-dipped plate, not less than IX or No. 28 gage, should be selected. Rolled tin plate should not be used for roofing, guttering or valleys.

One method employed in the preparation of steel for roofing purposes is to pickle the steel in acid baths to cleanse the sheets of scale and dirt. Unless this process is most carefully followed by thorough cleansing, minute particles of acid remain to form within the plate itself an agent for its final destruction.

Tin roofing must be painted, and with a good paint, to preserve it. Tin roofings can be shown which have lasted twenty or thirty years on railroad structures, but the danger of securing poor material and the cost of maintenance have made conservative builders very cautious in its use. It has the great advantage of being available for all slopes and it is adaptable to special and difficult conditions.

Plates for tin roofing should be prepared in the shop, and one side for use next to the sheathing given a coat of good paint. In soldering these sheets rosin and not acid should be used, as the latter may find an opening in the tin coat and attack and destroy the body.

MISCELLANEOUS METALS.

Sheet Lead.—Sheet lead has been used abroad considerably. Its main value is due to its immunity from action by acid gases, but it is expensive. It has a tendency to cold flow from its own weight and it expands rapidly under heat.

Copper.—Good copper is not easily corroded, but it has a high rate of expansion and is expensive. It is not always possible to secure it of good quality, and impure it corrodes much more rapidly than it should. It is only desirable for railroad buildings in rare cases.

Copper and Nickel Alloy.—For expensive building an alloy of copper and nickel is sometimes used which is said to be practically non-corrosive. It works much like sheet copper, but is harder.

CONCRETE ROOFINGS.

Reinforced concrete tile, several square feet in area, have been used to a considerable extent on large sheds and factory buildings where the slight leakage from their somewhat open joints is not objectionable. They are usually placed directly on the purlins and kept in place by wire to the framework. They must be carefully made from good materials and made as dense as possible. Improved methods of forming under pressure may improve their quality. Their use as yet is largely experimental.

Small cement tile are in use to a limited extent and the criticism given concerning the reinforced tile also applies to them. They are less expensive than clay tile but are more absorbent and brittle. Improved methods of manufacture and further tests may later develop their merits for some purposes, but no economy has so far been shown by their use.

Asbestos shingles and corrugated sheets made of Portland cement and asbestos under pressure give promise of good results. They can be made in different colors and have some desirable advantages. They have not been in use long enough to prove their merit.

METHODS OF APPLICATION.

Sheathing.—Wooden sheating improperly laid has caused the value of many good roofings to be underestimated. Green lumber should never be used for this purpose, as it will shrink in drying, with a resultant distortion of the covering material. With a prepared roofing the felt will be given a wavelike appearance and the seams or joints forced open. With a slate roof the slate will be liable to be broken or loosened. Tin or copper coverings may be subjected to open seams and on a tile roof the shoulders in an interlocking type will be broken off. Sheathing boards should be surfaced to a uniform thickness, and ordinarily a plain board will be satisfactory. The sheathing should be thick enough to prevent the roofing nail from going through it. On some types of buildings the building should be stiffened by running the sheathing diagonally to the rafters and purlins. The nailing should be reduced to a minimum.

Gutters.—The use of gutters on railway shops and on buildings close to the track should be discontinued where it can

be done without causing inconvenience. The cost of cleaning and maintenance are considerable because the sparks and shop dust that accumulate at such points contain injurious acids. The roof drainage can frequently be taken care of by a cement gutter on the ground to carry it to sewers or drains.

For railway purposes copper gutters are ordinarily the most economical when metal is used. Hand-dipped tin plate of the quality prescribed for roofing is better than galvanized iron.

For buildings covered with a prepared or built-up roofing the gutters can, if prepared with the proper care, give good results if formed in the roof and of the same material as the roofing.

Hanging gutters are frequently made of considerable length and must be strongly built, as otherwise they are liable to deflect from a uniform grade. They should be placed below the plane of the roof to avoid damage by sliding snow.

Flashing.—Saturated felt, properly coated with good asphalt or pitch preparations, will ordinarily give better results than metallic flashings for buildings subjected to gases and fumes. The metallic flashings are ordinarily suitable on a building not exposed to gases. The importance of the thorough construction of flashings and work around openings cannot be overestimated and the subject deserves a thorough discussion.

FIRE PROTECTION.

What should be one of the most important considerations in the selection of roofing is its fire-resisting qualities, especially if the building be where it can be exposed to fire from adjacent structures A roofing should, as far as possible, protect the structure from danger due to surrounding fires.

In congested districts a flat roof will have better fire-resisting value than a steeper one, as it is not so easily attacked by the flames and radiant heat, though it would afford a better resting place for flying brands. In large fires trouble frequently results with some types from the roofing being loosened about the edges, allowing it to curl up and the flames to get at the material underneath. Care should be taken to prevent this.

CONCLUSIONS.

The annoyance and indirect expense occasioned by leaky and short-lived roofs are rarely compensated for by any possible saving in first cost.

In selecting a roofing there should be considered:

(1) Chance of leaks due to character of construction.
(2) Probable life, including chance of damage by the elements and by wear from other causes.
(3) Fire-resisting value.
(4) Cost of maintenance.
(5) Cost of materials.
(6) Cost of laying.

The ordinary practice of depending merely upon guarantees in selecting roofings cannot be trusted to secure proper results.

Where proper materials and the requisite skill in application are available, built-up roofs of coal-tar felt, coal-tar pitch and gravel or slag are recommended for roofs with a pitch of two inches or less to the foot.

Where the roof is to be subjected to wear and where the character of the construction warrants the expense, flat tiles or brick should be used as a protective coating to the roofing instead of gravel or slag.

As a general proposition railroad buildings should be designed to accommodate this type to allow it to be used, and because of economy in construction and of decreased fire hazard. A pitch of from one-half to one inch to the foot is better than anything steeper. Nothing but straight-run pitch should be used.

No contracts should be made for a built-up roof without a complete and positive specification including flashings, and the contract prices should not be less than those of the materials specified, plus a reasonable amount to cover the cost of laying and profit. Thorough inspection of workmanship and material is recommended.

For slopes of from two to six inches to the foot fair results can be expected if the top coating of pitch be especially prepared. This can be successfully done only by skilled workmen, who are also necessary for its application. Especial care must also be taken in the selection and application of the stone or slag coating.

Asphaltic compounds have value for a built-up roof for the top coating on slopes of from two to six inches to the foot. They may also be desirable at points where good coal-tar cannot be obtained, except at a cost appreciably greater. They should not be used except where they can be obtained from reputable dealers with complete information as to their constituents and where they can be applied by men skilled in their use.

Ready or prepared roofings are recommended for use on small, temporary and other buildings, where the cost, considering maintenance, of more expensive buildings, is not justified. They are of value for steep slopes where a built-up coal-tar roof cannot be used, and for locations where the skilled labor necessary for a built-up roof is not available. The steeper the slope the greater their relative value and the wider their economical field. The heaviest varieties are, in general, the more desirable because of their chance for longer life and their greater fire-resisting value. In making selections the reliability of the manufacturer, service tests and the cost should be governing factors.

In the laying of built-up and prepared roofings thoroughness in the preparation of flashings and work around openings is of vital importance.

Slate and tile of suitable quality, properly protected and fastened, can be recommended on roofs with a pitch of six inches to the foot or over, where expense is not the governing feature, and where they aid in producing the desired architectural effect, except that where there is much chance of driving snow, eight inches to the foot should be the flattest slope allowed.

Wood shingles, except in isolated locations where there is small danger from sparks, should not be used.

Steel or impure iron materials should be avoided, no matter how protected.

The report is signed by O. P. Chamberlain, (C. & I. W.), chairman; Maurice Coburn, (Vandalia), vice-chairman; George W. Andrews, (B. & O.), J. P. Canty, (B. &. M.), D. R. Collin, (N. Y. C.), H. M. Cryder, Wm. T. Dorrance, (N. Y. C.), C. H. Fake, (M. R. & B. T.),P. F. Gentine, (M. P.), E. N. Layfield, (B. & O. C. T.), M. A. Long, (B. & O.), John S. Metcalf, Civil Engineer, H. Rettinghouse, (C. & N-W.), C. W. Richey, (P. R. R.).

Discussion on Buildings.

Mr. Lindsay: The committee has recommended the built-up roof of coal tar for pitch of two inches or less to the foot, and has permitted the use of asphalt only for on outer covering, in pitches of more than two inches. Is this association prepared to limit itself to the use of coal tar exclusively for roofing?

Mr. Coburn: We say that asphaltum compounds are valuable on the steep slopes. "They may also be desirable at points where good coal tar cannot be obtained except at a cost appreciably greater." We don't say they are not good on flat slopes. We do say coal tar is better under ordinary conditions.

A motion to adopt the recommendations was carried.

ROADWAY.

Subjects assigned were as follows:

(1) Consider revision of the Manual.
(2) Collect all known formulae for determination of size of waterways and tabulate them in such manner that they may be intelligently compared. Also consider whether, by the introduction of factors suiting local conditions, a general formula for waterways could not be used in all cases.
(3) Unit pressures allowable on the roadbed of different materials.
(4) Tunnel construction and ventilation.
(5) Investigate and report on the question of agricultural drainage in levee and marsh districts as they affect railways: (a) Laws and assessments. (b) Methods of construction of drainage channels through railways.
(6) Make concise recommendations for next year's work.

Sub-committees were appointed as follows:

(1) Revision of Manual: S. B. Fisher, chairman; Duncan MacPherson, J. R. W. Ambrose, H. J. Slifer.
(2) Formula for Waterways: W. D. Pence, chairman; John C. Beye, J. A. Spielmann.
(3) Unit Pressures on Roadbed: W. M. Dawley, chairman; Moses Burpee, J. G. Sullivan, Walt Dennis.
(4) Tunnel Construction and Ventilation: J. E. Willoughby, chairman; D. J. Brumley, C. Dougherty, W. P. Wiltsee.
(5) Drainage Districts: W. C. Curd, chairman; R. C. Young, Paul Didier, J. C. Sesser.
(6) Recommendations for 1911: The entire roadway committee.

REVISION OF THE MANUAL.

The sub-committee has several changes to suggest for the Manual, more especially in the matter of revising definitions, and expects to make its recommendations in the future.

FORMULAE FOR WATERWAYS.

The sub-committee has made a very thorough investigation of all known formulae and reports as follows:

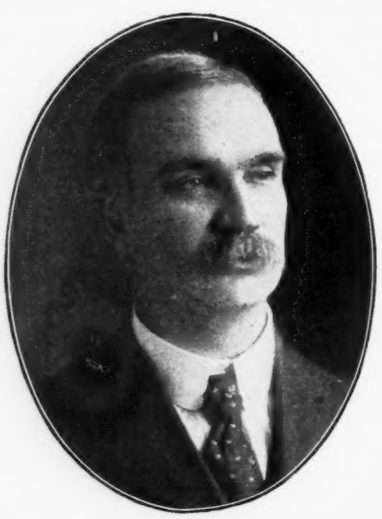
SIZE OF WATERWAYS.

Acting under substantially the same instructions during the previous year, the sub-committee charged with this matter compiled a large amount of valuable material much of it then freshly gathered from the members of the association, relating to current practice in connection with fixing the size of waterways. As a result of the studies made up to that time the roadway committee submitted to the annual convention in March, 1909, the following preliminary or tentative conclusions which were adopted by the association:

"(1) In determining the size of a given waterway, careful consideration should be given to local conditions, including flood height and flow, size and behavior of other openings in the vicinity carrying the same stream, characteristics of the channel and of the watershed area, climatic conditions, extent and character of traffic on the given line of road and probable consequences of interruptions to same, and any other elements likely to affect the safety or economy of the culvert or opening.

"(2) (a) The practice of using a formula to assist in fixing the proper size of the waterway in a given case is warranted to the extent that the formula and the values of the terms substituted are known to fit local conditions.

"(b) Waterway formulae are also useful as a guide in fixing



G. H. Bremner.

Chairman, Committee on Roadway.

or verifying culvert areas where only a general information as to the local conditions it at hand.

"(c) The use of such formulae should not displace careful field observation and the exercise of intelligent judgment on the part of the engineer.

"(d) No single waterway formula can be recommended as fitting all conditions of practice."

The concluding paragraph (d) of the foregoing conclusions represented the practically unanimous opinion of the members of the roadway committee, but it seemed desirable in view of the widespread interest displayed in the inquiry that the matter should be the subject of some further study. To this end it was suggested to the board that the topic should again be assigned, and this was done.

The studies during the past year have taken the form of an extended library search made for the purpose of bringing together "all known formulae for determining the size of waterways" as nearly as practicable in conformity with the board's instructions. After some discussion, approval was given to the plan of undertaking these further compilations through the medium of a thesis investigation under the direction of Prof. W. D. Pence, chairman of the sub-committee having the investigation in charge. The results of their investigations, in somewhat condensed form, are submitted as Appendix A to the present report. The inquiry began with a general survey of the literature of the subject, and this was supplemented among other features by a critical examination into the merits of the so-called "Dun Waterway Data" as a means of approach to the derivation of the general waterway formula contemplated in the board's instructions.

Although the matter thus brought together is lacking in completeness in certain of its aspects, the results were deemed worthy of preservation in permanent form as a progress report upon the subject, especially in view of the increasing interest displayed in this matter by engineers engaged both in the dimensioning of proposed new structures for carrying water through the roadbed and in defending their older structures under the fire of court attack.

The committee, after careful consideration of the results of its further investigations, although not prepared to modify the conclusions heretofore submitted to the Association that "no single waterway formula can be recommended as fitting all conditions of practice," nevertheless feels warranted in calling particular attention to certain relationships which give much promise in the direction of such general formula. The relationships referred to are best illustrated by introducing a graphical chart of the waterway data gathered by the late

Area Drained in Square Miles.	AREAS OF WATERWAY. Missouri and Kansas.	Cast Pipe. Banks over 15 ft. Use 80 per Cent.	Box and Arch Culverts. 1st Fig.—Diam. 2d. Fig.—Breadth	PERCENTAGE OF COLUMN 2. Illinois.	Indian Territory.	Texas.	New Mexico.
1	2	3	4	5	6	7	8
.01	2.0	1-24 in.	2 x 1 B				94
.02	4.0	1-24 "	2 x 2 "				92
.03	6.0	1-30 "	2 x 3 "				92
.04	7.5	1-36 "	2½ x 3 "				92
.05	9.0	1-42 "	3 x 3 "				92
.06	10.5	1-42 "	3½ x 3 "				92
.07	12.0	1-48 "	3 x 4 "				91
.08	13.5	2-36 " D	2½ x 3 "				91
.09	15	2-36 "	2½ x 3 "				91
.10	16	2-36 "	3 x 3 "				91
.15	25	2-48 "	3 x 4 "				89½
.20	32	1-42 "	6 x 4 A				89½
.25	38	1-48 "	6 x 5 "				89½
.30	44		6 x 5½ "				88
.35	51		8 x 4½ "				88
.40	56		8 x 5 "				88
.45	62		8 x 6 "				86½
.50	66		8 x 6 "				86½
.55	70		8 x 6½ "				86½
.60	74		10 x 4½ "				85
.65	78		10 x 5 "				85
.70	81		10 x 5½ "				85
.75	85		10 x 6 "				85
.80	88		10 x 6½ "				83½
.85	91		10 x 6½ "				83½
.90	94		10 x 6½ "				82
.95	97		12 x 5 "				82
1.0	100		12 x 5 "			98½	80½
1.1	110		12 x 6 "			98½	80½
1.2	120		12 x 7 "			98½	79
1.3	130		12 x 8 "			98½	79
1.4	140		14 x 6½ "			98½	77½
1.5	150		14 x 7 "			98½	77½
1.6	160		16 x 6½ "			98½	76
1.7	170		16 x 7 "			98½	76
1.8	180		16 x 7½ "			98½	74½
1.9	190		16 x 8 "			98½	74½
2.0	200		16 x 7 "			98½	73
2.2	220		18 x 8 "			98½	73
2.4	240		18 x 9½ "			98½	71½
2.6	260		20 x 8 "			98½	70
2.8	280		20 x 9 "			98½	68½
3.0	300		20 x 9½ "			98½	67
3.2	321		22 x 8½ "			98½	65½
3.4	340		22 x 9 "			98½	64
3.6	357		24 x 8½ "			98½	62½
3.8	373		24 x 9 "			98½	61
4.0	388		28 x 7 "			97	59½
4.2	403		28 x 7½ "			97	58
4.4	417		28 x 8 "			97	56½
4.6	430		28 x 8½ "			97	56
4.8	443		28 x 9 "			97	54½
5.0	455		28 x 9½ "			97	53
5.5	483		28 x 10 "			97	51½
6.0	509		32 x 7½ "			97	50
6.5	533		32 x 8 "			97	48½
7.0	556		32 x 9 "			97	47
7.5	579		32 x 10 "			97	45½
8.0	601		32 x 11 "			97	44
8.5	622		32 x 11½ "			97	43
9.0	641		32 x 12 "			97	42
9.5	660		32 x 12½ "			93½	41
10	679		32 x 13 "			93½	40
11	710					93½	38½
12	740					93½	37
13	775					93½	35½
14	805					93½	34½
15	835					93½	33½
16	865					93½	32½
17	890					94	31½
18	920					94	30½
19	945					94	29½
20	970					94	28½
23	1,015		Bridges designed to provide area to suit circumstances.	West of Streator use 80 per cent. East of Streator use 60 per cent.	West of Streator use 80 per cent. East of Streator use 60 per cent.	105	94
				North of Purcell use Column 2. South of Purcell use Texas Column.	North of Purcell use Column 2. South of Purcell use Texas Column.	105	94

Area Drained in Square Miles.	AREAS OF WATERWAY. Missouri and Kansas.	PERCENTAGE OF COLUMN 2. Illinois.	Indian Territory.	Texas.	New Mexico.
1	2	5	6	7	8
24	1,060			110	94
26	1,100			110	92
28	1,140			110	92
30	1,180			110	92
32	1,220			110	92
34	1,255			110	92
36	1,290			110	91
38	1,320			110	91
40	1,350			110	91
45	1,435			110	91
50	1,510			110	89½
55	1,580			115	89½
60	1,650			115	89½
65	1,720			115	88
70	1,780			115	88
75	1,840			115	88
80	1,900			115	86½
85	1,960			115	86½
90	2,015			115	86½
95	2,065			115	86½
100	2,120			120	85
110	2,220			120	85
120	2,315			120	85
130	2,405			125	83½
140	2,500			125	83½
150	2,580			130	82
160	2,665			130	82
170	2,745			130	80½
180	2,830			130	80½
190	2,900			130	79
200	2,970			130	79
220	3,115			130	77½
240	3,245			130	77½
260	3,370			130	76
280	3,495			130	76
300	3,615			130	74½
325	3,770			130	74½
350	3,900			130	73
375	4,035			130	73
400	4,165			130	71½
450	4,385			130	70
500	4,610			130	68½
550	4,825			130	67
600	5,030			130	65½
650	5,230			130	64
700	5,420			130	62½
750	5,610			130	61
800	5,800			130	59½
850	5,980			130	58
900	6,080			130	56½
950	6,230			130	....
1,000	6,380			130	....
1,100	6,705			130	....
1,200	6,960			130	....
1,300	7,230			130	....
1,400	7,480			130	....
1,500	7,725			130	....
1,600	7,960			130	....
1,700	8,195			130	....
1,800	8,390			130	....
1,900	8,625			130	....
2,000	8,820			130	....
2,200	9,240			130	....
2,400	9,605			130	....
2,600	9,970			130	....
2,800	10,320			130	....
3,000	10,640			130	....
3,500	11,445			130	....
4,000	12,160	West of Streator use 80 per cent. East of Streator use 60 per cent.		130	....
4,500	12,825		North of Purcell use Column 2. South of Purcell use Texas Column.	130	....
5,000	13,500			130	....
5,500	14,080			130	....
6,000	14,620			130	....
6,500	15,140			130	....

Fig. 1. Dunn Drainage Table; Santa Fe System.

James Dun in his exhaustive analysis of the practice of the Santa Fe system, covering many years' observation of the behavior of actual waterway openings under the widest possible range of conditions. The Dun figures are reproduced in numerical form in Table 1, and graphically in Fig. 1, covering the remarkable sweep of watershed area ranging from 0.01 square mile (6.4 acres) to 6,500 square miles (4,000,000 acres), and of waterway areas from 2 square feet to upward of 15,000 square feet cross-section.

In attempting to reconcile the widely varying values of exponents applied to the values of watershed areas in the various formulæ proposed for calculating culvert areas, it has been suggested in a previous report of this committee that the various authorities may have been dealing with run-off data observed from watershed areas of widely varying characteristics and shapes.

It should be stated that the committee has not, as yet, given

more than casual consideration to the hydraulic features of the culvert proper. It is respectfully suggested that in the assignment of work for the coming year that phase of the subject be assigned to this committee for investigation, with liberty to report further progress, if any, with reference to the general waterway formula contemplated in the board's instructions for the past two years.

CONCLUSIONS.

(1) There is a general relationship between the best-known waterway and run-off formulae. This relationship may be expressed by two terms, a varying coefficient and a varying exponent.

(2) The extent of this relationship for large and small areas is indicated by the Dunn waterway data, given in Fig. 1, and shown graphically by Fig. 2.

UNIT PRESSURES ON ROADBED.

The sub-committee has compiled considerable data and will hold a joint meeting with the Ballast Committee to consider this subject on Monday, March 20, 1911.

TUNNEL CONSTRUCTION AND VENTILATION.

This sub-committee would report progress.

DRAINAGE DISTRICTS.

The sub-committee dealing with this subject has made an exhaustive study of the laws of the various States and has compiled a complete list of the laws of Arkansas, Alabama, Arizona, Florida, Georgia, Virginia, Kentucky, Idaho, Maine, Texas, New Mexico, Tennessee, Mississippi, New York, Michigan, South Carolina, and North Carolina.

The following States have no drainage laws in effect: Colorado, Connecticut, Massachusetts, New Hampshire, Rhode Island, Utah, Vermont and Wyoming.

As these laws are very voluminous, the committee decided not to publish them in the Proceedings until they have been abstracted, and the sub-committee is now making up a compilation with that portion of the laws which affects railroads. This we also hope to publish in a later bulletin.

RECOMMENDATIONS FOR 1911.

The committee would recommend continuing each of the subjects assigned for the past year, with the exception of sub-committee II—Formula for Waterways, and for this the committee would substitute the study of Hydraulic Features of Culverts and Waterways, to be continued as a supplement to the subject, Formula for Waterways.

The report is signed by: Geo. H. Bremner, C. B. & Q., chairman; S. B. Fisher, M. K. & T., vice-chairman; J. R. W. Ambrose, G. T.; John C. Beye, C. R. I. & P.; D. J. Brumley, I. C.; Moses Burpee, B. & A.; W. C. Curd, M. P.; W. M. Dawley E. R. R.; Walt Dennis, K. C. S.; Paul Didier, B. & O.; C. Dougherty, C., N. O. & T. P.; Duncan MacPherson, N. T.; W. D. Pence, University of Wisconsin; John C. Sesser, G. N.; H. J. Slifer, C. G. W.; J. A. Spielman, B. & O.; J. G. Sullivan, C. P.; J. E. Willoughby, L. & N.; W P. Wiltsee, N. & W.; R. C. Young, L. S. & I. & M.

APPENDIX A.

Waterway for Culverts.

This paper is a digest of the material compiled in the course of a thesis investigation by A. F. Gilman and G. W. Chamberlin in 1909-1910, under the direction of Prof. W. D. Pence, University of Wisconsin.

The following compilation of formulas for culvert areas and for the determination of run-off is believed to include all the better known formulas besides several not customarily used by American railroad engineers. The nomenclature is taken without change from the original sources.

The Myers Formula.

$$A = c\sqrt{M},$$

where A = the area of waterway required, in square feet.
M = the area drained, in acres.
c = 1 as a minimum for flat country.
c = 1.6 for hilly compact ground.
c = 4.0 as a maximum for mountains, rocky country.

Major Myers recommended this formula as applying well to the water courses which he had been able to examine, which lay chiefly on the line of the Richmond, Fredericksburg & Potomac Railroad.

The Talbot Formula.

$$A = c\sqrt[4]{M^3},$$

where A = the waterway area necessary, in square feet.
M = the area drained, in acres.

This formula is not intended for use for drainage areas of more than 400 square miles. It was derived with especial

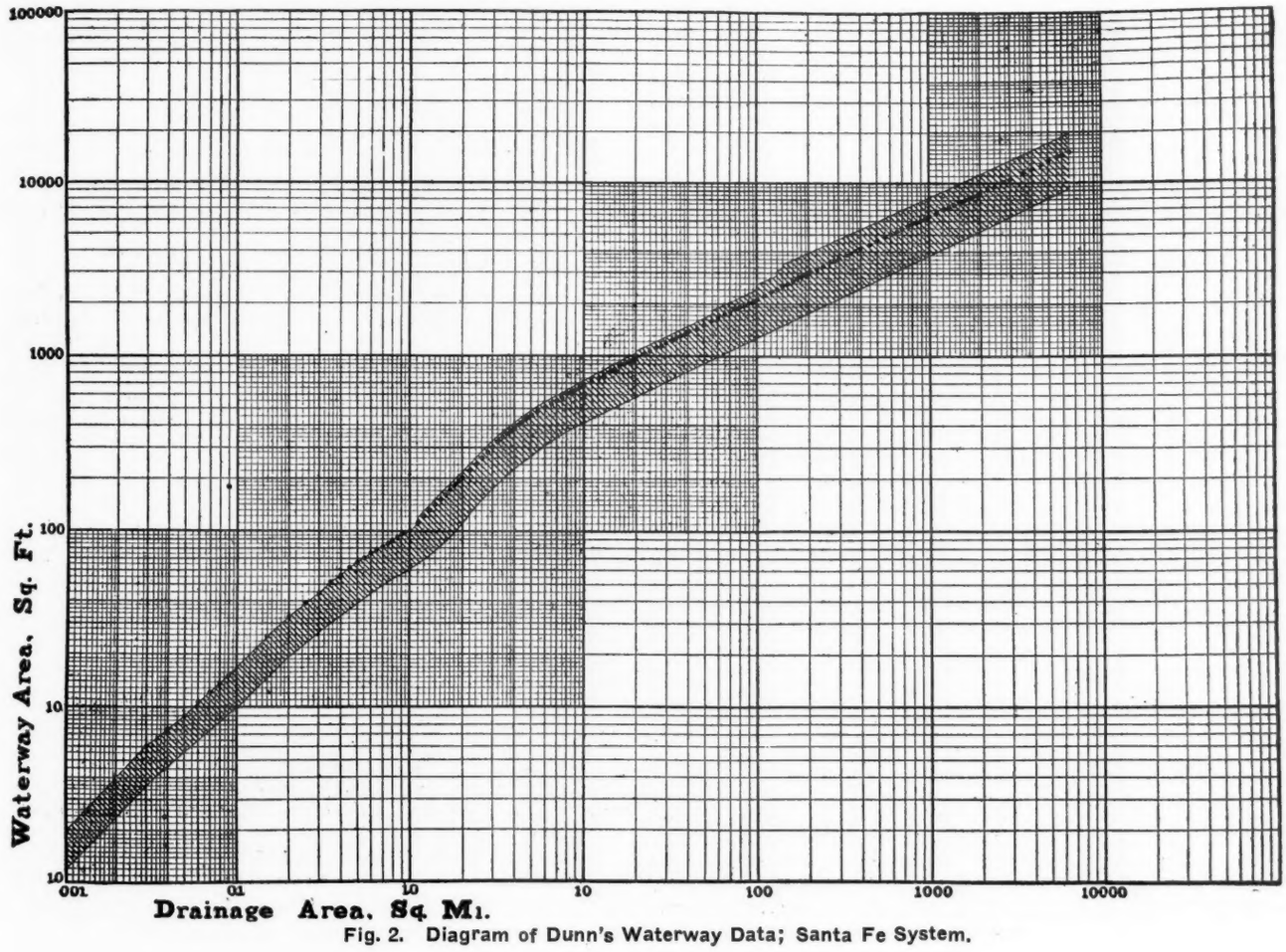


Fig. 2. Diagram of Dunn's Waterway Data; Santa Fe System.

reference to areas under 77 square miles in size: "For rolling country subject to floods at a time of melting snow, and with a length of valley three or four times the width, let c be one-third. For valleys with stream longer in proportion to the area, decrease c. In districts not affected by accumulated snow and where the length of the valley is several times the width, one-fifth or one-sixth or even less may be used. For steep side slopes, especially where the upper part of the valley has a much greater fall than the channel at the culvert, c should be increased."

This formula is used very generally in the southwestern and western portion of this country and appears to give excellent results for the smaller areas.

The Peck Formula (better known as the Missouri-Pacific formula.

$$\text{Area of waterway in square feet} = \frac{\text{Drainage area in acres}}{c}$$

c varies from 4 to 6, depending on the country.

In very mountainous country, where slopes of hills and mountains are steep and abrupt, c is equal to 4. In ordinary flat rolling country, such as is found in good agricultural sections, c is equal to 6.

The Wentworth Formula.

$$a = d^{\frac{2}{3}},$$

where a = the sectional area of the waterway, in square feet.
d = the drainage area, in acres.

This formula was derived in connection with work on the Norfolk & Western Railway and is especially fitted to the conditions along that line, and in general to the conditions in the Southeastern States. In cases of less rainfall, or if the ground be quite flat, the author states that the two-thirds power of the drainage area is too great for the square feet of area needed in the waterway. In the observations of Mr. Wentworth, 60 per cent. of the resulting area may be taken as the lower limit.

The Murphy Formula.

$$A = \frac{Q}{V} = \frac{Q}{C\sqrt{RS}}$$

where A = area of waterway, in square feet.
V = mean velocity, in feet, per second
R = hydraulic radius = range in stage in time of flood. (See explanation below.)

$$c = \frac{a + \frac{b}{n} + \frac{c}{S}}{1 + \left[a + \frac{c}{S}\right]\frac{n}{\sqrt{R}}}$$

where a, b and c are constants and n is the coefficient of roughness of the bed.

S = slope of surface.

"It can be shown that the hydraulic radius

$$R = \frac{A}{P} = \left[\frac{(I + 2d)\,X}{(I + 2d)\sqrt{(1 + X^2)}}\right]d \quad \ldots\ldots\ldots (3)$$

in which I is the bottom width of a trapezoidal section, d is the depth and X is the slope of the sides. It can be seen from equation (3) that for any given values of d and X, R approaches d as I increases; for the case of floods, therefore, it may be assumed that R = the difference in stage between high and ordinary low water."

"This method of finding the waterway at a given place on a stream consists in finding the drainage area in square miles above the place under consideration, the greatest change in stage of the stream at this place and the slope of the surface. By multiplying the drainage area M by q (the maximum discharge in second-feet per square mile that is to be expected in that portion of the country), we find Q; dividing Q by V, using for R the maximum range of stage, and for S the measured slope of surface of the stream, we have the necessary area of waterway. The greatest error in the use of this method will result from an incorrect measurement of the slope. The formula calls for the slope of surface, and surface slope of a stream is not necessarily the slope of the bed. The slope is not the same at all stages nor always the same for a given stage. If the place under consideration is near the mouth of a large tributary the slope of the main stream will be affected by the stage of the tributary. Overflow and flooding of lowlands is frequently the result of backwater, due to reduction of surface slope. The smaller the slope used the greater will be the computed waterway. If there is a possibility of the waterway becoming partly clogged with drift, logs or ice, or its being in the influence of backwater from a tributary, the computed area must be increased by a liberal amount."

The Dun Data.

A reproduction of the 1906 table may be found in the accompanying Table I. This data was derived principally from observations made along the lines of the Santa Fe Railway in Missouri, Kansas, Indian Territory and Texas.

The C., B. & Q. Formula.

$$Q = \frac{3000\,M}{3 + 2\sqrt{M}}, \text{ or using } V = 10 \text{ ft. per second,}$$

$$A = \frac{300\,M}{3 + 2\sqrt{M}}.$$

where Q = the total discharge from the area in cubic feet per second.
M = the drainage area, in square miles.
A = the waterway in square feet, using the velocity through the culvert as 10 ft. per second.

The Cooley Formula.

No. 1. $Q = 200\,M^{\frac{3}{4}}$, or $A = 20\,M^{\frac{3}{4}}$.
No. 2. $Q = 180\,M^{\frac{3}{4}}$, or $A = 18\,M^{\frac{3}{4}}$.

Notation is the same as for C., B. & Q. formula.

The Tidewater (Virginia) Railway Formula.

$$A = 0.62\,M^{7/10}$$

where M = area drained (watershed) in acres.
A = Neat area of waterways, in square feet.

"Where the stream has a flat fall, add 30 per cent.; where double openings are used, add 20 per cent. to total cross-section area."

The El Paso & South Western Railway Formula.

$$Q = 17\sqrt{\frac{8000}{A}}$$

where Q = the maximum run-off per square mile of drainage area.
A = the total drainage area in square miles.

This is practically the formula by Mr. Joseph P. Frizell, which he worked up from the records of flow over the Holyoke dam, Massachusetts, for a period of 50 years, and it appears in the original form in his book on hydraulics.

The Lauterberg Formula.

$$\text{Average discharge of a river} = \phi = \frac{1{,}000{,}000}{31{,}530{,}000}\,\text{ChF} = 0.03171\,\text{ChF}$$

where ϕ = average quantity discharged per second.
F = the area drained in square kilometers.
h = the total yearly rainfall in inches.
c = 0.20 for marshy soil.
= 0.25 for level plains.
= 0.30 for rolling ground.
= 0.35 for low hills.
= 0.45 for hilly country like the Ardennes, the Odenwald and the Eifel.
= 0.55 for the Black Forest and the Vosges.
= 0.70 for high rocky mountains.

Lauterberg endeavored to frame a rational estimate as to the probable discharge of streams by means of the above formula, which is based upon data collected in Switzerland.

The Fanning Formula.

$$Q = 200\,M^{\frac{5}{6}}$$

where M is the area of watershed in square miles and
Q is the volume of discharge in cubic feet per second.

The Dredge Formula.

$$Q = 1300\frac{M}{L^{\frac{2}{3}}}.$$

Notation the same as in the Fanning formula.
L = the length of drainage area in miles.

The Dickens Formula.

$$Q = c \times 27\,M^{\frac{3}{4}}.$$

Q = 200 $M^{\frac{3}{4}}$, for Madras Presidency, India.
Q = 500 $M^{\frac{3}{4}}$, for Central Provinces, India.
Q = 825 $M^{\frac{3}{4}}$, for Bengal and Bahar, India.
Q = 1,200 $M^{\frac{3}{4}}$, for Upper Kaveri, India.
Q = 2,200 $M^{\frac{3}{4}}$, for Gadamatti, India.

The O'Connell Formula.

$$Q = 458\,[\sqrt{(640\,M + 4.58)} - 45.8].$$

This formula is best adapted to small districts.

The notation is the same as that of the Fanning formula.

The Kutter Formula (derived by Ganguillet and Kutter in 1869).

$$Q = \frac{1421\,M}{0.311 + \sqrt{M}}$$

This formula is adapted to Swiss streams. The notation is the same as that of the Fanning formula.

The Hering Formula.

$$Q = \frac{D\,M\,v}{L} \text{ or } \frac{D\,M\,v}{t_1}$$

where Q and M are the same as those of the Fanning formula and

L = the length of the river.
v = the mean velocity of the stream.
D = the entire depth of rain flowing off during a storm.
t_1 = the time taken for a drop of water falling near the periphery of watershed to reach the culvert.

The Possenti Formula.

$$Q = c_2 \frac{R}{L_1}\left(M_2 + \frac{M_1}{3}\right)$$

c_2 = a coefficient with an average value of 1,010.
R_2 = the depth of rainfall in inches for 24 hours.
M_2 = the area of hilly or mountainous part of watershed, in square miles.
M_1 = the area of level or flat part of watershed, in square miles.
L_1 = the length in miles of the stream from its source to the point of observation.

This formula applies especially to mountain streams of moderate size in the Apennines.

The Burkli-Ziegler Formula.

$$q = c\,r\,\sqrt[4]{s/a}$$

where q = the water reaching the sewer in cubic feet per acre per second.
r = the average intensity of rain during heaviest fall in cubic feet per acre per second.
s = the general grade of the drainage area in feet per hundred.
a = the area drained, in acres.
c = a coefficient, for average areas it equals 0.625.

The observations extended up to slopes of 10 ft. per 100, but were limited to small areas of less than 50 acres. This formula is especially applicable to sewer design.

The Coghland Formula.

$$P = t\,c\,R^{1.9}$$

where P = the inches of rainfall discharged by stream.
t = a coefficient for time, the value of which is governed by the length of time the freshet lasts.
c = a coefficient of rainfall varying with the quantity of rain.
R = the average daily rainfall in inches during the freshet.

This formula is applicable to drainage districts of moderate size in New South Wales.

The following values of t and c are given by the author:

Length of freshet in days..	350	Value of t in inches..	2.6
Length of freshet in days..	300	Value of t in inches..	2.5
Length of freshet in days..	250	Value of t in inches..	2.4
Length of freshet in days..	200	Value of t in inches..	2.2
Length of freshet in days..	150	Value of t in inches..	2.1
Length of freshet in days..	100	Value of t in inches..	2.0
Length of freshet in days..	50	Value of t in inches..	1.9
Length of freshet in days..	25	Value of t in inches..	1.8
Rainfall in inches.....	0.40	Value of c in inches..	0.95
Rainfall in inches.....	0.35	Value of c in inches..	0.90
Rainfall in inches.....	0.30	Value of c in inches..	0.85
Rainfall in inches.....	0.25	Value of c in inches..	0.80
Rainfall in inches.....	0.20	Value of c in inches..	0.75
Rainfall in inches.....	0.15	Value of c in inches..	0.70
Rainfall in inches.....	0.10	Value of c in inches..	0.65

The Craig Formula.

$$Q = 440 \times B \times N \text{ hyp. log } \frac{8\,L^2}{B}$$

where Q = the total discharge in cubic feet per second.
N = c v i, where v = the velocity toward the culvert in feet per second.
i = the number of inches of rainfall.
c = the coefficient of discharge.
L = the extreme length of the drainage area.
D = the mean width of the drainage area.

The McMath Formula.

$$Q = c\,v\,\sqrt[8]{S\,A^4} = A\,c\,v\,\sqrt[8]{s/A}$$

where c = the proportion of rainfall that reaches sewers.
v = the number of cubic feet of water falling upon an acre of surface per second during the period of greatest intensity of rain. It is practically the same as the rate in inches per hour.
s = the mean surface grade in feet per thousand.
A = the area drained in acres.
Q = the discharge in cubic feet per second.

This formula was derived with especial reference to St. Louis conditions.

The Chamier Formula.

$$Q = 640 \times R \times C \times M^{3/4}$$

where Q = the discharge in cubic feet per second.
R = the average rate of the greatest rainfall anticipated in inches per hour for such duration as will allow the flood water flowing to the outlet from the farthest extremity of the catchment area.
c = a coefficient of surface discharge, giving the proportion of rainfall that may be expected to flow off the surface.

The above formula has been tested by Mr. Chamier on streams in India having drainage areas of from 20 acres to 400 square miles.

The Cramer Formula.

$$Q = \frac{c_3\,R_3\,m\,M\,(S_2)^{1/3}}{9 + (0.0658\,m\,R_2\,M)^{1/3}}$$

where Q = the discharge in cubic feet per second.
R_2 = the mean annual rainfall in inches.
$S_2 = \frac{e_1 + e_2}{l}$ = the mean slope and declivity of the whole basin; e_1 being its average altitude in feet, e_2 being the altitude of the point of discharge, and l being the average distance in feet traveled by the water from the boundaries of the watershed to the point of measurement.
c_3 = a variable coefficient.
= 186 for rough natural basins of rivers.
= 697 for smooth, comparatively level and impervious areas like well-built cities.
m depends on the total area M, the flat area F, which is likely to be inundated in freshets, and the mean annual rainfall R_3, such relation being expressed by:

$$m = 1 - \sin\left(-\tan^{-1}\frac{709\,F}{M\,R_3}\right)$$ for the simple case when F is distributed in an approximately uniform manner throughout the whole basin, whereas if F is concentrated only at the lower end of the basin, we must place

$$m = 1 - \sin\left(-\tan^{-1}\frac{1418\,F}{M\,R_3}\right)$$

The Italian Formulas.

$$Q = \frac{1819\,M}{0.311 + \sqrt{M}} \quad (1)$$

$$Q = \frac{2600\,M}{0.311 + \sqrt{M}} \quad (2)$$

The notation in these formulas is the same as that of the Fanning formula. No. 1 is applicable to streams in northern Italy, and No. 2 to small brooks in the same region.

The Kuichling Formulas.

$$q = \frac{44{,}000}{M + 170} + 20 \quad (1)$$

$$q = \frac{127{,}000}{M + 370} + 7.4 \quad (2)$$

Here q = the discharge in second-feet per square mile, and M = the drainage area in square miles. These equations were derived from conditions similar to those in the valley of the Mohawk River. They were obtained from a great amount of flood data on both American and European streams. Equation No. 1 gives the discharge during floods which may occur occasionally. Equation No. 2 gives the discharge during floods that occur but rarely.

The Murphy Formula.

$$q = \frac{46{,}790}{M + 320} + 15$$

The notation here is the same as that of the Kuichling formulas. This equation was derived from a large amount of flood data on streams of the northeastern United States which Mr. Murphy had collected.

The Gray Formula.

$$Q = 5.89\ A^{\frac{3}{4}}$$

where Q = the discharge in second-feet per acre, and
A = the drainage area in square miles.

In his discussion of logarithmic diagram of the Dunn data, Prof. W. D. Pence found that by drawing tangents to the curve at various points the exponents of the equations of these tangents varied from unity for very small areas to one-half for the largest areas drained. This is a very interesting discovery, and it may be that it represents the law for which engineers have been continually looking, but without further verification of the Dun figures it is impossible to draw any final conclusion in regard to the matter.

Discussion on Roadway.

Mr. Churchill: I believe there should be an investigation all over the United States with a view to finding a general waterway formula by which a change in the coefficient will be applicable to the different sections, and I believe that this committee is in better shape to take up such a formula than any other body in the United States.

Prof. Pence: If the members of the association will support the committee by responding to the circular which the committee plans to send out, by platting a few points on the diagram, it is believed that considerable progress can be made.

A motion to receive the report as information was carried.

RECORDS AND ACCOUNTS.

The Board of Direction assigned the following work:

(1) Recommend a form and system for keeping sidetrack records.

(2) Continue the study of estimate forms for construction and maintenance work.

(3) Consider revision of the Manual.

(4) Make concise recommendations for next year's work.

The following sub-committees were appointed:

Sidetrack Records: M. C. Byers, chairman; C. W. Pifer, Thomas Maney.

Bridge Estimate Forms: Edward Gray, chairman; R. W. Willis, E. E. Hanna.

Building Estimate Forms: W. H. Sellew, chairman; J. H. Milburn.

Water Service Estimate Forms: C. H. Gerber, chairman; J. M. Brown.

Section Foreman's Material Report: Henry Lehn, chairman; J. E. Turk, T. H. Gatlin.

SIDETRACK RECORDS.

The work outlined for this sub-committee was as follows:

(1) To collect data in the nature of forms and methods used by railroads for keeping sidetrack records. (2) To formulate a definite recommendation for a method of preparing and keeping such records, with particular attention to the following features: (1) Reporting completion of sidetracks. (2) Keeping permanent record of same. (3) Periodically checking location and length to insure the record always being correct.

The information considered desirable for such a record generally consists of the following: Location of sidetrack by mile post and station; length; alinement; gradient; actual cost, and by whom assumed; character, age and weight of rail; character and size of ties; description of bridges and culverts; date of construction; memorandum of agreement, if any, covering construction and maintenance; title to property occupied.

The investigation developed that the railway companies have not as a general thing devised very complete systems for keeping sidetrack records, although the necessity for such is generally admitted but not fully appreciated. There would seem to be no reason why the same care should not be given to maintaining careful records of sidetracks as is given to keeping records of main tracks and other physical assets of a railroad company.

In the analysis of the subject the sub-committee came to the conclusion that a sidetrack record should be used for the following reasons:

(1) To provide data for compiling reports to state railway commissions and the Interstate Commerce Commission. (2) To provide data for annual reports. (3) Keep a record of ownership of sidetracks. (4) Keep records for taxation purposes. (5) Provide a convenient method by which the officers of a railway in direct charge of maintenance or changing of sidetracks may become familiar with the conditions under which the tracks are constructed and maintained. This is especially valuable in connection with sidetracks which are owned wholly or in part by private parties or corporations, the maintenance of which is performed by the railroad company and the cost charged against the owner.

Failure to keep accurate sidetrack records has resulted in much controversy between interested parties and oftentimes endless search through correspondence files in order to develop the information which ought to be readily found and for which there is constant call. In a large percentage of industrial tracks there are other than railway interests. The title to the track and property and maintenance of same makes it just as important to keep a complete and accurate record, which should supplement the written contracts, as to keep records of titled property. In addition, there is necessity for keeping better records on account of constantly increasing demands of local and national authorities for data in connection with physical condition of property, for which reliable records must be within easy reach. It is felt that the importance of this feature of railroad records cannot be too greatly emphasized and that it has not heretofore been given the prominence it deserves.

The committee presents to the association for adoption the form proposed for sidetrack records.

The general scheme of the form is to have a permanent record, which will be corrected annually, and which will, as far as possible, show accurately the track situation at all times, and it is so planned as to permit additions or reductions in length to be indicated immediately upon completion of the work without causing the form to be rewritten.

The form needs very little explanation, as the headings of the columns show exactly what information is to be recorded. In presenting this form the committee has in mind the neces-

H. R. Safford.

Chairman, Committee on Records and Accounts.

sity for a form that will fit all conditions, and this accounts for four or five columns which show in different methods the location of track, as the same method for indicating the location could not be used under all conditions.

It is proposed that this form be printed on tracing paper, so that as many copies as are desired can be taken from it by blueprinting, the original to be retained in the local office. At the end of the year or other prescribed period, the local officers should correct the report and send new prints to the office of the chief engineer or whatever general officers may require such information.

In detailed explanation of the use of the columns the following instructions are proposed to accompany this form:

Column No. 1. Show location of sidetracks referred to mile posts, which method would be used for tracks which are not a part of yards or within station limits. In such cases the mile post location will be the mile and plus of the switch nearest the mile post measured in the direction in which the mileage is carried.

Column No. 2. Give reference indicating that the sidetrack is on the right or left side of the main track.

Column No. 3. Give name of station at which track is located.

Column No. 4. Give name of county and state.

Column No. 5. Give name or number of township or school district.

Column No. 6. Give name or number of track, as it may be designated.

Column No. 7. Indicate whether the track is a spur or connected at both ends.

Column No. 8. Show construction authority number.

Column No. 9. Give number of contract, if any exists, covering construction, operation or maintenance.

Column No. 10. Show date sidetrack was completed.

Column No. 11. Give character, age and weight of rail.

Columns Nos. 12, 13, 14 and 15. Show actual length of track at the end of prescribed record year, dividing the ownership between the railway and outside interests.

Columns Nos. 16, 17, 18 and 19. Show changes which may be made to track during the record period. In these columns the plus sign should be used to indicate track length which is added, and the minus sign should be used for track length which is taken up.

Column No. 20. Show any miscellaneous information that has a bearing upon the track and which is not provided for by separate column.

A space should be provided between the various stations to permit of additional sidetracks being recorded without making a new sheet.

All totals and all figures indicating changes during the year should be shown on the tracing paper in pencil, also the last two figures of the year in which the report is made, but all other figures should be made with India ink. The local officers preparing the sidetrack record should retain the original form and at the end of the period for which the report is to be made, should, after correcting their previous reports to date, send the necessary sets of blue prints to the office of the chief engineer, one for use until a new report is made, and the others to be filed as a permanent record. The tracing paper form should not be used for reference but be filed in a dust-proof box until it is necessary to correct it or make necessary blue print copies.

All tracks should be reported on the sidetrack record in linear feet of track.

In reporting weight of rail with which the original track was constructed, this should be reported as linear feet of track.

The committee recommends to the association for adoption in the Manual of Recommended Practice the proposed form for sidetrack record shown as Exhibit A.

BRIDGE ESTIMATE FORMS.

This sub-committee was instructed to continue the study of this subject, which was begun but not completed in the 1909 report, following the general idea of having a form which would provide a uniform method for making such estimates and furnishing a guide to the estimator to avoid errors of omission. They very soon determined that it would not be practicable to attempt to follow in the preparation of this form the scheme of printing the various items that enter into general bridge work. The character of construction varies too much to make such a plan feasible, and it was therefore concluded by the sub-committee, which conclusion was indorsed by the general committee, that in the design of such a form the front page should be left blank as far as the list of items is concerned, but that on the reverse side of the sheet should appear a list of the principal items which enter into various kinds of bridge construction and which would be a guide to the estimator, and insure uniform arrangement of items in the estimates and prevent omission of important features.

In the preparation of this list of items it was found quite easy to include too much detail, and the committee has therefore not attempted to go beyond the principal items. The situation in regard to an estimate for bridge work which would fit all classes of structures is somewhat different from the preparation of a similar form for track estimates, but in the design of the face of this form an attempt has been made to make it consistent in arrangement with the form recommended and adopted for track estimates, with the exception of printing the details.

The instructions to sub-committees C and D were of the same general character as those given to sub-committee B, and forms of a similar design were presented.

SECTION FOREMAN'S MATERIAL REPORT AND REVISION OF THE MANUAL.

The committee does not offer any suggestion or changes with reference to the general subject of revision of the Manual. The committee has been unable to do much more than complete the work on estimate forms and preparing sidetrack record, and while some attempt was made to study several of the forms, particularly those applying to section foreman's material reports, adopted by the association, nothing conclusive was determined in this direction.

The report is signed by: H. R. Safford (Edgar Allen American Manganese Steel Company), chairman; H. J. Pfeifer (Terminal Railroad Association), vice-chairman; J. M. Brown (C. R. I. & P.), M. C. Byers (St. L. & S. F.), T. H. Gatlin (Southern), C. H. Gerber, consulting engineer; Edward Gray (Southern), E E. Hanna (M. P.), Henry Lehn (New York Central), Thos. Maney (L. &. N.), J. H. Milburn (B. & O.), C. W. Pifer (Ill. Cent.), W. H. Sellew (Mich. Cent.), J. E. Turk (P. & R.), R. W. Willis (C. B. & Q.).

Discussion on Records and Accounts.

Mr. McDonald: I would like to ask the committee whether they gave consideration to the question of large yard groups. Is it the intention that each track in a group shall be placed on this blank, or are they to be treated as groups?

Mr. Safford: The idea was that a condition of that kind cannot be handled as a group. You cannot individualize every track in a large yard.

Mr. Brooke: There is one omission that I would like to see taken care of. Nearly all private sidings are covered by an agreement, and this would be a convenient place for it.

Mr. Safford: Column 9 covers it. It should be contract number instead of "Construction number."

President: That will be corrected.

A motion to adopt the form was carried.

Mr. Kittredge: I would like to ask for some explanation of the item of "general expense," in the form for "water service estimated."

Mr. Safford: That was intended to mean a general heading for what might follow in the way of miscellaneous items that were not listed. The classification of the things that are ordinarily met in estimates of that kind appears in items 1 to 8. From that point on, it is miscellaneous that we did not feel like listing.

Mr. Kittredge: I was wondering why it did not appear in the other blanks.

Mr. Safford: It should have appeared in the others. That was an over-sight.

The President: The Committee will add that to the blanks in which it does not now appear.

Mr. Kittredge: Engineering and train service are grouped together in Article XIII, while in Article VI, the article "Train Service" is given again. Is there some special kind of engineering and train service covered?

Mr. Safford: That is another typographical error.

The President: "And train service" will be omitted.

Mr. Brooke: I suggest "Miscellaneous expense" be substituted for "General expense."

The President: That is acceptable to the committee.

A motion to adopt the form was carried.

UNIFORM GENERAL CONTRACT FORMS.

The committee was instructed to take up the following work:

(1) Review and revise uniform general contract forms presented at Tenth Annual Convention.

(2) Make concise recommendations for next year's work.

The committee has thoroughly considered the report made at the 1909 convention and published in Bulletin 108, and has made a study of the principal contracts in use. The plan of having an agreement form of two pages separate from the general contract conditions, is approved by the committee, and the agreement form presented in that report has been reconsidered and revised and is presented herewith with recommendations for adoption.

In small or unimportant contracts this agreement form, which is designated as Form A, may be used alone, but in larger contracts the "General Conditions" statement designated as Form B may be inserted, using the agreement form as a folder with the introductory page at the beginning of the contract and the signatures at the end.

Specifications relating to the particular work can either be included in the folder or attached to the back.

The committee has, in the agreement, made the "Contractor" the party of the first part, and the "Company" the party of the second part and has, therefore, in preparing the "General Conditions," placed the provisions relating especially to the duties and rights of the "Contractor" first and those relating to the duties and rights of the "Company" last.

The committee has outlined for future meetings the formation of the remaining sections, which, in general, will cover the following terms: Property and right of entry; temporary suspension of work; annulment; measurement and approval of work; estimates and payments.

CONCLUSIONS.

The committee especially presents for approval:

(1) The general scheme of having the two-page general agreement, Form A, as a folder within which the other por-

tions of the contract can be bound, thus permitting a concise contract form or a large contract form, according to the requirements of the case.

(2) The agreement—Form A—as presented herewith:

The committtee presents for discussion and suggestions:

(1) The scheme of arrangement of B—General Conditions.

(2) The composition of the 28 sections enumerated.

For next year's work it is recommended that preparation of a standard contract form be continued on the lines already begun.

The report is signed by: J. C. Irwin (R. Railroad), chairman; W. G. Brimson (Q., O. & K. C.), vice-chairman; E. F. Ackerman (L. V.); F. H. Alfred (C., H. & D.); Wm. Archer (B. & O. S.); William Ashton (O. S. L.); W. G. Atwood (L. E. & W.); W. L. Breckinridge (C., B. & Q.); E. H. Lee (C. & W. I.); F. W. Smith (C., C., C. & St. L.); W. F. Tye (Civil Engineer); C. A. Wilson (Consulting Engineer).

CONSTRUCTION CONTRACT.

Agreement.

This agreement, made this .....day of..... in the year .....by and between..... .....party of the first part, herinafter called the Contractor, and..... party of the second part, hereinafter called the Company.

WITNESSETH, That, in consideration of the covenants and agreements hereinafter mentioned, to be performed by the

J. C. Irwin.
Chairman, Committee on Uniform General Contract Forms.

parties hereto and of the payments hereinafter agreed to be made, it is mutually agreed as follows:

The Contractor will furnish all the necessary transportation, materials, superintendence, labor and equipment and will execute, construct and finish in an expeditious, substantial and workmanlike manner to the satisfaction and acceptance of the Chief engineer of the Company.

..... in accordance with the plans hereto attached or as hereinafter described and the following general conditions, requirements and specifications, forming part of this agreement.

The work covered by this contract shall be commenced .....and be completed on or before the.....day of.....191..... .....

And in consideration of the completion of the work described herein, and the fulfillment of all the stipulations of this agreement to the satisfaction and acceptance of the Chief Engineer of the Company, the said Company, its successors or assigns hereby agree to well and truly pay, or cause to be paid, to said Contractor, the executors, administrators, successors or assigns of said Contractor, as the case may be, the amount due the Contractor, based on the following prices..... .....

IN WITNESS WHEREOF, The parties hereto have duly executed this instrument in duplicate the day and year first above written.

WITNESS:

....
....

CONSTRUCTION CONTRACT.

General Conditions.

1. Bond.—The Contractor agrees, at the time of the execution and delivery of this contract and before the taking effect of the same, to furnish and deliver to the Company a good and sufficient bond of indemnity to the amount of..... .....dollars, as security for the faithful performance, by the Contractor, of all the covenants and agreements on the part of the Contractor contained in this contract. The security in such bond of indemnity must be satisfactory and acceptable to the Company.

This bond shall remain in force and effect in such amount, not greater than that specified, as shall be determined by the Chief Engineer, until the final completion and acceptance of the work.

2. Contractor's Understanding.—It is understood and agreed that the Contractor has satisfied himself by careful personal examination as to the nature and location of the work, the form of the surface of the ground, the character, quality and quantity of the materials to be encountered, the character of the plant, structures, equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and all other matters which can in any way influence this contract, and no information upon any such matters derived from the maps, plans, profiles, drawings or from any source whatever, shall in any way affect any risk or obligation, or relieve him from fulfilling any of the terms of this agreement. No verbal agreements or conversations with any officer, agent or employe of the Company, either before or after the execution of this contract, shall affect or modify any of the terms or obligations herein contained.

3. Intent of Plans and Specifications.—All work that may be called for in the specifications and not shown on the plans, or shown on the plans and not called for in the specifications, is to be executed and furnished by the Contractor as if described in both these ways; and should any work or material be required which is not denoted in the specifications or plans, either directly or indirectly, but which is nevertheless necessary for the proper carrying out of the intentions thereof, the Contractor is to understand the same to be implied and required, and is to perform all such work and furnish any such material as fully as if they were particularly delineated or described.

4. Permits.—The Contractor shall, at his own cost and expense, except as specifically provided in this contract, secure the necessary permits for the work included in this contract and will be responsible for violations of any laws, rules or regulations.

5. Protection.—Whenever the local conditions, laws or ordinances require, the Contractor shall furnish and maintain, at his own cost and expense, necessary passageways, guard fences and lights and such other facilities and means of protection as may be required.

6. Rights of Various Interests.—Whenever work being done by Company forces or by other Contractors is contiguous to work covered by this contract, the respective rights of the various interests involved shall be determined by the Engineer, to secure the completion of the various portions of the work in general harmony.

7. Consent to Transfer.—The Contractor agrees not to let or transfer this contract or any part thereof (except for the delivery of material) without consent of the Chief Engineer, given in writing. Such consent does not release or relieve the Contractor from any or all of his obligations and liabilities under this contract.

8. Superintendence.—The Contractor agrees to constantly superintend all the work embraced in this contract in person or by a duly authorized manager acceptable to the company.

9. Timely Demand for Points and Instructions.—The Contractor shall not proceed until he has made previously timely demand upon the Engineer for, and received from him, such points and instructions as may be necessary as the work progresses. The work shall be done in strict conformity with such points and instructions.

10. Report Errors and Discrepancies.—If the Contractor, in the course of the work, finds any discrepancy between the plans and the physical conditions of the locality, or any errors in plans or in the layout as given by said points and instructions, it shall be his duty to immediately inform the Engineer. Any work done after such discovery, until verified, will be done at the Contractor's risk.

11. Preservation of Stakes.—The Contractor must carefully preserve bench marks, reference points and stakes, and in case of wilful or careless destruction he will be charged with the resulting expense and shall be responsible for any mistakes that may be caused by their unnecessary loss or disturbance.

12. Inspection.—All work and mterials shall at all times be open to the inspection, acceptance or rejection of the Engineer

or his duly authorized representative. The Contractor shall at all times provide sufficient, safe and proper facilities for such inspection.

13. Defective Work or Material.—Any omission or failure on the part of the Engineer to disapprove or reject any work or material shall not be construed to be an acceptance of any defective work or material. The Contractor shall remove, at his own expense, any work or material condemned by the Engineer, and shall rebuild and replace any work or material so condemned without extra charge, and in default thereof the same shall be done by the Company at the Contractor's expense—or in case the Chief Engineer should not consider the defect of sufficient importance to require the Contractor to rebuild or replace any imperfect work or material, he shall have power, and is hereby authorized, to make any deduction from the stipulated price that he may see proper.

14. Indemnity.—The Contractor agrees to indemnify and save harmless the Company for and from all claims, demands, payments, suits, actions, recoveries and judgments of every nature and description brought or recovered against it, for or on account of any injuries or damages received or sustained by any party or parties by reasons of any act or omission of the said Contractor, his agents or employes, in the construction of said work or by or in consequence of any negligence or carelessness in guarding the same.

15. Settlement for Wages.—Whenever, in the opinion of the Chief Engineer, it may be necessary or conducive to the progress of the work to secure to any of the employes of the Contractor any wages which may then be due them, the Company is hereby authorized to pay such laborers the amount due them or any lesser amount, and the amounts so paid them, as shown by their receipts, shall be deducted from any moneys that may be or become payable to said Contractor.

16. Liens.—If at any time anyone employed by the Contractor, either to perform work as a sub-contractor or laborer or otherwise, or to furnish any materials, shall file or give notice of any mechanic's or other liens therefor, the Company is hereby authorized to pay and discharge the same if it shall deem best so to do, and to deduct the amount so paid from any moneys which may be or become due and payable to the Contractor.

17. Work Adjacent to Railroad.—Whenever the work embraced in this contract is near the tracks, structures or buildings of this Company or of other railroads, the Contractor shall use extraordinary care and vigilance to avoid injury to persons or property. The work must be so conducted as not to interfere with the movement of trains or other operations of the railroad; and if in any case such interference be necessary, the Contractor shall not proceed until he has first obtained specific authority and directions therefor from the proper officer of the Railroad Company and has the approval of the Engineer.

18. Risk.—The work in every respect shall be at the risk of the Contractor until finished and accepted.

19. Order and Discipline.—The Contractor shall at all times enforce strict discipline and good order among his employes, and any employe of the Contractor who shall appear to be incompetent, disorderly or intemperate, or in any other way disqualified ofr or unfaithful to the work entrusted to him, shall be discharged immediately on the request of the Engineer, and he shall not again be employed on the work without the Engineer's written consent.

20. Contractor Not to Hire Company's Employes.—The Contractor shall not employ any of the Company's employes.

21. Intoxicating Liquors Prohibited.—The Contractor shall not permit the sale, distribution or use of any intoxicating liquors upon or adjacent to the work, or allow any such to be brought upon, to or near the line of the railway of the Company.

22. Cleaning Up.—The Contractor must, before the work is finally accepted, at his own expense, clear away from the Company's property and from all public and private property all temporary structures, rubbish and waste material resulting from his operations.

23. Engineer and Chief Engineer Defined.—Wherever in this contract the word Engineer is used, it shall be understood as referring to the Chief Engineer of the Company, acting personally or through an assistant duly authorized in writing for such act by the Chief Engineer, and wherever the words Chief Engineer are used it shall be understood as referring to the Chief Engineer in person, and not to any assistant engineer.

24. Power of Engineer.—The Engineer shall have full power to reject or condemn all work or material which, in his opinion, does not conform to this agreement; to direct the application of forces to any portion of the work which in his judgment requires it; to order the force increased or diminished, and to decide every question that may arise between the parties relative to the execution of the work.

25. Adjustment of Dispute.—All questions, differences or controversies which may arise between the Contractor and the Company, under or in reference to this agreement, or its performance or non-performance, or the work to which it relates or in any way whatever pertaining to or connected with said work, shall be subject to the decision of the Chief Engineer, and his decision shall be final and conclusive to both parties.

26. Order of Completion; Use of Completed Portions.—The Contractor shall complete any portion or portions of the work in such order of time as the Engineer may require. The Company shall have the right to take possession of and use any completed or partially completed portions of the work, notwithstanding the time for completing the entire work or such portions may not have expired; but such taking possession and use shall not be deemed an acceptance of the work so taken or used or any part thereof. If such prior use increases the cost of the work, the Contractor will be entitled to such extra compensation as the Chief Engineer may determine.

27. Changes.—The Company shall have the right to make any changes that may be hereafter determined upon, in the nature or dimensions of the work, either before or after its commencement, and such changes shall in no way affect or void this agreement, but the difference in the value of the work shall be adjusted by the Engineer. If such changes diminish the quantity or extent of the work to be done, they shall not, under any circumstances, be construed as constituting, and shall not constitute, a claim for damages or for anticipated profits on such work.

In case of any work being done under a lump-sum contract price, and the quantity of work actually furnished upon completion of the work should vary and prove more or less than the quantities shown on the original plans and provided for by the specifications, then the contract lump-sum price is to be adjusted in the final payment accordingly. If the contract provides a schedule of unit rates for variations in the work, then the adjustment is to be made on the basis of such unit rates, either adding or deducting the corresponding amounts according to whether the quantity of each class of work was increased or decreased over the amounts originally covered by the lump-sum bid; if the contract does not contain such a schedule of unit rates, then the value of all such additions or omissions is to be established by the Engineer, and the adjustment made accordingly.

28. Extra Work.—No bill or claim for extra work or material shall be allowed or paid unless the doing of such extra work or the furnishing of such extra material shall have been authorized in writing by the Engineer, and the price to be paid fixed by the Chief Engineer in writing before any part of such work was done or material furnished.

The Chief Engineer, in fixing the price for the doing of work or the furnishing of material not provided for in this agreement, may either fix a unit price or a lump-sum price or may, if he so elects, provide that the price shall be determined by the actual cost, to which shall be added.....per cent to cover general expense and superintendence, profits, contingencies, use of tools, Contractor's risk and liability. If the Contractor shall perform any work or furnish any material which is not provided for in this agreement, or which was not authorized in writing by the Engineer previous to the doing of the work or the furnishing of material, said Contractor shall receive no compensation for such work or material so furnished, and does hereby release and discharge the Company from any payment therefor.

If the Contractor shall proceed with such extra work or the furnishing of such extra materials after receiving the written authority therefor, as hereinbefore provided, then such work or material, stated in the written authority of the Engineer, shall be covered, governed and controlled by all the terms and provisions of this agreement, subject to such prices as may be agreed upon or determined by the Chief Engineer.

If the Contractor shall decline or fail to perform such work or furnish such extra material as authorized by the Engineer in writing, as aforesaid, the Company may then arrange for the performance of the work in any manner it may see fit, the same as if this agreement had not been executed, and the Contractor shall not interfere with such performance of the work.

Discussion on Uniform General Contract Forms.

The report was accepted as information without discussion.

GRADING AND INSPECTION OF MAINTENANCE OF WAY LUMBER.

In the classification of lumber the question of the absence or presence of defects is one of the greatest importance, and the various lumber associations of the country have adopted

standard grades for the kinds of lumber which they manufacture, according to which they grade their product by sizes and by the quality, as determined by the absence or presence of certain standard defects.

To insure uniformity, it is obviously desirable that in ordering and purchasing lumber, the railroads follow standard specifications which shall be considered as such by both the producer and consumer. This principle has been recognized in the association in the adoption of the standard specifications for Southern yellow pine bridge and trestle timbers, which are now the standard specifications of the Yellow Pine Manufacturers' Association and of the American Society for Testing Materials.

Since the adoption of these standard specifications, the Yellow Pine Manufacturers' Association and American Society for Testing Materials have issued these standard specifications in the form of a small pamphlet, and the manufacturers have attempted to live up to these specifications in the manufacture of grades of timbers applied to bridge and trestle construction. Apart from these specifications, comparatively little has been done in the way of formulating standard rules for the grading of maintenance of way lumber that are recognized both by the railways and manufacturers.

At the 1909 convention of the Master Car Builders' Association a committee was appointed to act in conjunction with similar committees from the American Railway Master Mechanics' Association, the Railway Storekeepers' Association and the lumber manufacturers' associations throughout the country and to prepare specifications and grading rules for car and locomotive lumber.

At the 1910 convention of the Master Car Builders' Association a report was submitted on this subject, which was subsequently adopted by the above referred to railway and lumber manufacturers' associations. This report consisted of a description of the various woods used by the railway companies for car and locomotive lumber, a list of standard defects, with appropriate photographs illustrating these, and the grading rules for each kind of lumber.

A great deal of the matter contained in these specifications is applicable to maintenance of way lumber, and several of the manufacturers' associations have submitted to this committee specifications for maintenance of way lumber, using the descriptions of woods and standard defects already adopted by these associations. These specifications are printed in full as an appendix to the report.

In submitting these specifications as a matter of information to members of this association, the committee wishes to emphasize that it is desirable to adopt a series of specifications of this character at the earliest possible date. The splendid results obtained from the joint adoption of such standard rules for bridge and trestle timbers has already been pointed out. The various lumber associations have indicated their readiness to co-operate with the members of this association for the purpose of having similar rules adopted for maintenance of way lumber.

The committee suggests that the work assigned to it for the next year consist in the preparation of similar specifications for classes and kinds of lumber not included in the specifications submitted in this year's report, and the consideration of those submitted with a view towards recommending the adoption of standard specifications for maintenance of way lumber.

The report is signed by: W. H. Sellew, M. C., chairman; F. H. Bainbridge, C. & N. W.; E. O. Faulkner, A. T. & S. F. Railway; R. Koehler, S. P.; Dr. Hermann Von Schrenk, St. L. & S. F.; B. A. Wood, M. & O.

Discussion on Grading Rules for Maintenance of Way Lumber.

Dr. Herman Von Schrenk, (R. I. Frisco): The idea of the committee was to request the various manufacturers' associations to present concrete rules for the various classes of railway material under which they would be able to furnish railway lumber. The chief criticism which the committee has found hitherto was that the lumber manufacturers generally criticized the railway specifications, saying that they were numerous and various; that what they would like to see was a standard specification for one class of material, adopted by the railway organizations. The committee therefore requested that the manufacturers' associations submit such specifications as they believed would be standard, and those have been printed preliminary to their general adoption, and the lumber manufacturers' associations have on their part agreed that unless they are very materially changed, they would issue those as standard specifications on their part.

J. H. Waterman (C. B. & Q.):. The Railway Storekeepers' Association, at the sixth annual convention, 1909, passed the following resolution:

Resolved, That a committee of five be appointed by the president to confer with the Master Car Builders' and Master Mechanics' Associations, and request the adoption by them of the commercial grading rules as the standard of lumber specifications by the railways:

This committee went to Atlantic City in 1909 and attended the Master Car Builders' and Master Mechanics' conventions, presented the resolution, and succeeded in having a committee appointed from each association to act jointly with the committee from the Railway Storekeepers' association to draft standard specifications to cover all classes of lumber used in cars and locomotives.

The committee met several times and was assisted very materially by the manufacturers' associations north, south, east and west. The manufacturers were very glad to cooperate with the joint committee referred to above and change any of the established rules which they had to conform with the rules which the committee felt were best.

This enabled the committee to make a complete report to the convention of the Master Car Builders and Master Mechanics which met at Atlantic City in 1910 and present standard specifications for all classes of lumber used in cars and locomotives. This report was adopted unanimously by the Master Mechanics' Association and the Master Car Builders' Association.

In August, 1910, we learned that the American Railway Engineering and Maintenonce of Way Association had appointed a committee on rules for the grading and inspection of maintenance of way lumber.

We immediately wrote your president, Mr. Fritch, on August 23, and offered your committee, through him, any information which we had gathered in connection with our work in preparing the standard specifications which were adopted by the Master Mechanics' and Master Car Builders' associations.

On August 30 your president acknowledged receipt of the letter and advised:

"I wish to thank you for your letter and will instruct our committee to avail themselves of your kind offer." We have met with your committee during the past year and have given them what assistance we had at hand.

The question arises:

We ask you to take some action endorsing what your committee has done and continuing them with authority. We will co-operate with them if you think best.

We hope that in the very near future there may be a standard specification adopted which will be uniform. We do not want to be understood as advancing a proposition that all roads should use the same class of lumber in the same place. We would like the American Railway Engineering and Maintenance of Way Association in their own way to say that as the various lumbermen's manufacturing associations of the United States have adopted rules and specifications for the grading of all classes of lumber which we use, the railways will accept these grading rules as their standard for the inspection of all lumber which they buy, and designate the lowest grade inspected under the commercial grading rules, which will be acceptable to the railways of this country for each particular purpose.

Favorable action by this association can result in only one thing; greater ease, more uniformity, less frequent disputes in connection with the inspection of lumber, and a greater certainty of an adequate supply being promptly secured especially in busy times.

E. T. Brown, (B. & O.): The Baltimore & Ohio has repaired, during the past year, a good many miles of second and third class, and they have needed a good deal of maintenance of way lumber, switch timbers and bridge lumber for special or temporary work. I know that orders were placed for lumber, and at the end of six months that lumber was not furnished, and the railway company had to ship lumber from west of the Alleghenies to the east side of the Alleghenies to do the work at the time it had to be done. I think it would be a great saving in many ways to the railways to have a standard under which one road could buy the same lumber from a mill that the other would, and the stock would be the same.

A motion to receive the committee's report as information, was carried.

CONSERVATION OF NATURAL RESOURCES.

In pursuance of the request from President Baker of the National Conservation Congress, a report was transmitted to Thomas R. Shipp, executive secretary of that organization, on September 3, 1910, by the chairman, of which the following is a part:

"On May 13, 1909, an elaborate report was transmitted to

the committee by the National Conservation Commission, through its secretary, Mr. Shipp, containing valuable suggestions as to the possibilities of railway companies assisting the work of conservation by thorough methods of prevention and control of forest fires, and the cultivation of timber for railroad purposes, the use of sawed instead of hewed ties, the use of treated timber, and the necessities for the extension of the supply of creosote, and other features relating to timber resources. This report was transmitted by the committee, to the American Railway Engineering and Maintenance of Way Association, published by the association, and distributed throughout the country in one of its bulletins.

"Dealing directly, as it does, with those features of conservation that affect the railway companies and their patrons, and having a circulation among railway officers covering the United States, as well as large portions of Canada and Mexico, the results should be exceedingly beneficial to the cause of conservation.

"In March of this year the special committee was established as one of the standing committees of the association, at the same time the personnel was largely increased, bringing into membership a number of prominent railway officers of this country and Canada.

"The work of the committee has been divided into subcommittees for the purpose of specialization, with an outline for investigation as follows: (1) tree planting and general reforestation. (2) coal and fuel oil resources. (3) iron and steel resources.

A sub-division of the work, as per statement following, was recommended: (1) Tree Planting and General Reforestation, (a) extent of existing forests considered in connection with increase of growth and consumption. (b) judicious selection of tree varieties for planting, the locality and soil conditions considered. Possibility of value from growth on cut-over land. (c) methods of planting and cultivation, with cost of same, considering possibilities from cut-over lands. (d) anticipated results at maturity from trees so produced. (e) methods and cost of caring for and protecting existing forests. (2) Coal and Fuel Oil Resources. (a) extent of existing supplies, considered in connection with consumption. (b) extent of waste in production. (c) economic consumption, giving consideration to practical use of by-products. (3) Iron and Steel Resources. (a) supplies of raw material, considered in connection with consumption. (b) waste in production. (c) best methods of protecting finished products from destructive influences.

"The committee will continue on the lines of investigation as shown, and holds itself in readiness to co-operate with the National Conservation Commission and its kindred and subsidiary organizations, as well as other national societies for the furtherance of the great principles of conservation of the national resources."

The very serious forest fires that occurred in the fall of 1910 were the subject of thorough discussion at a meeting of the Lake States Forest Fire Conference, held in St. Paul under the auspices of the Minnesota State Forestry Board and Minnesota Forestry Association, December 6 and 7, at which meeting the following was included in the resolutions adopted:

"We further recommend that the burning of all debris on the rights of way of the various railways be under the control and direction of the State Forest Patrol. Further, That under special conditions directed by the State Forest Patrol, the railway companies maintain a patrol, properly equipped, following their trains; also that all railway and logging locomotives and traction engines must be equipped with the most practical spark-arresting devices (subject to inspection and approval of the commission)."

The report is signed by A. S. Baldwin (I. C. R.), chairman; E. O. Faulkner (A. T. & S. Fe.), vice-chairman; Moses Burpee (B. & A.), W. A. Bostwick (Carnegie Steel Company), F. F. Busteed (C. P. R.), E. B. Cushing (S. C. L.), W. F. H. Finke (S. R.), J. W. Kendrick (A., T. & S. Fe), A. L. Kuehn (American Creosoting Company), G. A. Mountain (Canadian Railway Commission), William McNab (G. T.), C. L. Ransom (C. & N. W.).

Discussion on Conservation of Natural Resources.

A motion to receive the report as a progress report was carried.

ELECTION OF OFFICERS.

The following were elected officers of the association for the ensuing year:

President, W. C. Cushing; vice-president, Edwin F. Wendt; secretary, E. H. Fritch; treasurer, G. H. Bremner; directors, three years each, A. S. Baldwin, C. F. Loweth.

PRACTICE REGARDING THE MANUAL.

The President: The subject of practice regarding the manual will be a fruitful topic for discussion. Before we proceed with that, I would like to read from our fourth annual proceedings the remarks made by Mr. Berg: "It is desirable for the board of direction to consider the question of appointing a standing committee on standard specifications and definitions, whose duty it shall be to prepare final standard specifications and definitions, based on the adopted reports of the various existing standing or special committees on investigation, presented heretofore, or to be presented hereafter to the association; the work of this committee to be in the nature of a board of review, or revision, so that it can present to the association uniform and complete specifications or lists of definitions, which, if adopted by the association, shall be known and published as the recommended standards of the association.

Mr. McDonald: Without any idea of casting doubt on what Mr. Berg did, I would say the manual, as shown by the minutes of the board of direction, was first suggested by A. W. Sullivan, our vice-president. It was done in the earlier days of the association, but was not put into effect until some time later. There seems to be quite a strong sentiment among a large number of our members that we should not publish a manual as representing the selected subjects and matters which this association has acted upon, and I think it is due to the board of directors that they should know it, so we can abandon the plan of adopting standard specifications, and create ourselves into a body for the purpose of eliciting information from its members, and publishing it broadcast. We must pursue one course or the other, and I think it should be our aim to endeavor to promulgate specifications which can be used in securing competitive prices by the purchasing agents. I believe that board of review should be appointed, and it should not be from the board of directors, but from the membership at large.

Mr. Kittredge: I should be very sorry indeed to see the manual done away with. I appreciate that it is very difficult for an association with such a large attendance to discuss thoroughly and put into final shape, the reports of more than one or two committees. I think the remarks by Mr. Berg in regard to the manual contain a good deal that is worth considering. The question of appointing a board of review, outside of the board of direction, is rather a new thought to me, but if such a board could be obtained—and I have no doubt it could—I believe it would be better than to have it made a part of the duty of the present board. The members of the board of direction, when they get together, have a great many things to discuss. The work of editing and collecting, comparing and adjusting the various recommendations so that there will be no two in conflict, will take an enormous amount of time and careful study. I think it is absolutely essential, now that our manual has reached the size it has, that it should be very carefully and closely edited in all its parts, so that there may not be discrepancies between the different parts.

Mr. McDonald: In order to get an expression and discussion on the question, I move that we discontinue the publication of the manual.

Motion seconded.

Mr. Brooke: It would be a great loss, not only to the association and all its members, but to the railway world in general, to discontinue the publication of our manual, which goes all over America and to foreign countries as a reference book. It would be a great advantage to have the matter thoroughly reviewed and edited before being published, and all unnecessary and conflicting matter eliminated or brought into conformity.

Mr. Byers: It seems to me the question of the desirability of publishing the manual is not entirely what some of us have in mind. The manual is a source of information, is a very desirable and useful thing and it is very desirable that we shall continue to collect information of the character that we are placing in the manual, and bring it together as it is brought together in the manual. It seems to me the question, is the degree of backing that this association shall give to what the manual states is recommended practice. There are several reasons why it is not entirely desirable that we shall give too much backing to these recommendations. I think most of us have occasion, at times, to deal with the courts, and sometimes I think there has been an experience that the manual can be used in the courts to increase the difficulties of the engineers in dealing with the problems that he must confront in that way. The manual is apt to be taken as being not a recommended practice, but the only recommended practice. That is certainly not the case.

Mr. Rose: The necessity for the manual is to bring disjointed reports together, where one can find easily the work of the association. If the manual were discontinued, it would be necessary to search through all the volumes of the association's proceedings to find out what the associa-

tion thought about different things. It has occurred to me that we might have two manuals, one called "The Manual of Recommended Practice" and the other, "The Digest of the Committees' Recommendations," or "Committees' Reports."

The President: "Manual for Railway Engineering and Maintenance of Way Work."

Mr. Trimble: The aim was to get a title for that book, which would not indicate that the practice embodied in the book was the only practice that might be acceptable.

Mr. Loweth: The manual is good or bad, depending upon what is put into it. It seems to me we might very well have just the discussions and the votes that we take here in the convention, and then before anything goes into the manual, have it voted upon by letter ballot, so that nothing will go into the manual, unless it is approved by a majority vote of the membership of the association.

Mr. Camp: If the manual was not to be used I would be in favor of some kind of an index which would refer the reader back to the volumes of the proceedings in which the subject might be found. The manual should aim to cover principally the fundamentals of the subject, the underlying principles. If it is attempted to go into detail as largely as has been the case heretofore, the manual will not be successful, because we will have to keep revising it every year or two. In regard to the responsibility of the association in recommending certain things, I think it would be a splendid thing to have on the title page of the proceedings of the association and of the manual a statement to this effect: "It is the desire of this association that it be distinctly understood that practice which does not conform to the recommendations herein is not necessarily bad or incorrect practice."

Mr. Trimble: May I ask for the reading of the notice which it is intended shall be published in the manual of recommended practice and in our publications. It might clear up some of this discussion.

The President: The extract from the constitution is as follows: "The object of this association is the advancement of knowledge pertaining to the scientific and economical location, construction, operation, and maintenance of railways. Its action is recommendatory and not binding upon its members.

F. S. Stevens: It appears to be generally conceded that the manual should be continued. It is also the general opinion, I think, that there should be a board of review or a committee on revision. I would offer, therefore, as a suggestion, that a board of review should include, ex-officio, the chairman of all committees, so that in the matter of review they would have an opportunity to be heard. I think also we should have all ex-presidents on such a board as these men have had the advtantage of knowing everything that has passed before, and possibly we should also add some of the other officers. A board constituted in this way would be able to review the manual in a very satisfactory manner, I think, and greatly improve the value of the publication.

Mr. Wendt: At the present time the next issue of the manual is in print, subject to the modifications that this convention will make. Therefore, the money has already been spent. I am strongly in favor of a continuation of the publication of the manual because it enables us to readily turn to the results of the work of the convention, without looking through the large number of volumes which are already on the shelves of the libraries. Furthermore, the proceedings of this year are going to mean three volumes instead of two last year and one volume in former years; so that the number of volumes of our proceedings issued each year is increasing very rapidly.

The manual ought to be an expression of the wisdom of this association. It is not such today. There are conclusions in the manual that do not represent the wisdom of the engineers of this country and they have gotten into the manual by virtue of a lack of consideration. The legal responsibility of the manual need hardly be considered except from this standpoint: If a lawyer undertook to introduce the manual into a court he would be immediately required by the rules of evidence approved by the courts to test the manual by evidence, and unless he could prove by competent evidence that the principles outlined in our manual were the common, ordinary and usual principles which govern railways in the district over which that court had jurisdiction, the manual would have no standing. This is simply an application of the rules of evidence of the courts. We do get into trouble today because some portions of our manual have not been thoroughly considered. For illustration: An attorney called me up some time ago and asked: "Will you come over to court and testify for our company in a damage case that the American Railway Engineering Association has decided that a certain clearance is required?" I said: "No, sir, I will not; firstly, because it has made no such decision; and secondly, if it has made any such decision, it would be unwise." The attorneys are being told by somebody that there is such a thing in existence as the manual, that is above reproach, that is infallible, that contains the wisdom of the engineers of the country. That is not the fact, because adequate consideration has not been given to this question.

I think we should continue the manual, but divest our minds of any thought of issuing it in a way to indicate that it represents that which is infallible, or that which does not admit of variable application. It does seem to me that we could well afford to have a manual that would contain standard specifications under which ballast can be purchased; standard specifications under which rails can be purchased; standard specifications for track bolts, track nut-locks, spikes, screw spikes, tie plates, frogs, switches, guard rails, etc., specifications which would enable railways to get competition in the matter of prices, and specifications that would enable the railways to reduce their stock piles.

In my judgment the specifications contained in our proceedings are just as binding from the standpoint of responsibility when published in the proceedings as when published in the manual, and the specifications submitted by the committee on frogs and switches this year, and the specifications submitted last year are the best specifications ever put out in this country at the present time. I have compared them with the New York Central and Pennsylvania Lines specifications and I make that statement. So far as the manual is concerned, we can well afford to delay the publication of certain standard specifications, using one illustration, until such time as we are confident that they are complete and that they represent the best practice under which railways could make purchases all over the country.

I hope, gentlemen, that there will be no decision to discontinue the manual, because the voluminous proceedings of this association require that there shall be a digest. We should divest our minds of the idea that the manual commits us in any further degree from the standpoint of legal responsibility than the proceedings.

M. C. Byers: I move as an amendment to the motion before the house, that the governing committee present to the association a letter ballot giving the members an opportunity to decide upon which one of the three following things they wish done:

First, the abolishment of the manual; second, the continuation of the manual as at present; third, the continuation of the manual in a modified form as suggested by the governing committee at the time of sending out these bulletins.

Motion seconded.

Mr. McDonald: My object in presenting the original motion was to draw out discussion on the matter, and I think the discussion has been quite illuminating. With the permission of the gentleman who seconded me, I now desire to withdraw the motion.

Motion withdrawn.

Mr. McDonald: My own opinion is, instead of taking any action it should be delegated to the board of direction for such action as they see fit.

The matter was referred to the board of direction for such action as it deems the interests of the association warrant.

CONCLUDING BUSINESS OF THE CONVENTION.

Resolutions were unanimously carried expressing appreciation of the efforts made and the results obtained by the Railway Age Gazette and the Railway and Engineering Review in publishing daily editions during the convention.

It was announced that the change in name of the association and amendments to the constitution, submitted to letter ballot, had both passed.

A resolution was passed expressing the thanks of the association to the committee on arrangements for its earnest efforts. The committee on arrangements presented the retiring president with the first pin bearing the new name of the association. The convention then passed a resolution expressing appreciation of the work of the retiring president, and the convention adjourned.

VISIT TO THE NEW NORTH WESTERN TERMINAL.

A party of members and guests of the association were taken yesterday afternoon by C. A. Lichty, inspector of purchases of the Chicago & North Western, for a tour of this road's new passenger terminal.

NOTICE TO EXHIBITORS.

The exhibition of the Railway Appliances Association will close Friday night at 10 o'clock. Boxes will be brought up immediately afterward and the exhibitors may begin to get exhibits ready for shipment. They may make arrangements for removal any time after the hour for closing.

THE VOTING CONTEST FOR THE MONO-RAIL CAR.

The voting contest to determine which of the technical schools in the United States shall receive the model of the mono-rail car being demonstrated by Mr. Brennan at the Coliseum furnishes a good chance for the railway officers visiting the Coliseum to do a good turn for their alma maters. This little car was built especially for the appliances exhibition, and it embodies all the features of the large car which has been in successful operation. The ballots may be secured at the bureau of information, space A, in the very center of the Coliseum. The award will be made after the exhibition closes.

REGISTRATION—AMERICAN RAILWAY ENGINEERING ASSOCIATION ACTIVE MEMBERS.

Blaess, A. F., Asst. Eng. M. W., I. C. R. R., Chicago, Ill.
Brimson, W. G., V.-P. and G. M., Q. O. & K. C., Kansas City, Mo.
Chamberlain, O. P., Ch. Eng., C. & I. W. R. R., Chicago, Ill.
Cowper, J. W., Worden-Allen Company, Chicago, Ill.
Hanlon, W. B., Civil and Mining Engineer, Cleveland, Ohio.
Kent, A. S., Eng. M. W., C. I. & L. Ry., Chicago, Ill.
Liggett, Thomas, Jr., Ch. Eng., Western Allegheny R. R., New Castle, Pa.
Pence, W. D. (Editor of Publications), Prof. R. R. Eng., Univ. of Wis., Madison, Wis.
Pfeifer, N. J., E. M. W., Ter. R. R. Assn., St. Louis, Mo.
Ringer, Frank, Pr. Asst. Eng., M. K. & T., Parsons, Kan.
Thorne, J. O., Master Carp., C. B. & Q. Ry., Beardstown, Ill.
Young, G. F., Asst. Div., B. & O. R. R., Cleveland, Ohio.
Young, R. C., Ch. Eng., L. S. & I. and Munising Rys., Marquette, Mich.

RAILWAY SIGNAL ASSOCIATION PUBLICATIONS.

C. C. Rosenberg, secretary of the Railway Signal Association, is distributing a circular to the members, giving a list of the publications printed by the association which are now available. These are as follows: Vols. I and II, Digest of Proceedings, 1895 to 1905, inclusive; Vol. IV, Proceedings of 1907; Vol. V, Proceedings of 1908; Vol. VI, Proceedings of 1909; Vol. VII, Proceedings of 1910, and The Index to Signal Literature. These are cloth-bound and all $1 per copy. The Index is complete to April, 1910, contains 185 pages, and gives alphabetical lists of books, pamphlets, catalogues, etc., and a list of articles relating to railway signaling that have appeared in periodicals, preceded by a list of these periodicals. Paper-covered pamphlets may also be had, as follows: Specifications for wires and cables; double-braided weatherproof hard-drawn copper line wire; rubber insulated signal wire for current of 660 volts or less; aerial braided cables for current of 660 volts or less; galvanized E. B. B. iron bond wires; double-braided weatherproof galvanized B. B. iron line wire; rubber insulated lead-covered armored submarine cable for 660 or lower voltage service; double-braided weatherproof hard-drawn copper-clad steel line wire; all at 25 cents per copy. The report of the committee on electric signaling for electric railways is also available at 25 cents per copy, and the standards (59), as approved by the association, size 10 in. by 14 in., in blue-print, Van Dyke positive, or Van Dyke negative form, may also be had. Prices of these will be given on application. The price of the membership certificates is $1.25 each.

AMENDMENTS TO CONSTITUTION.

After carefully considering a petition signed by ten active members, the board of direction of the association acted favorably on a proposition to amend the constitution, and the amendments proposed were submitted to letter ballot on January 18, 1911, which resulted in an affirmative vote. The important changes in the constitution include the following:

In article I, the name of the association was changed to the American Railway Engineering Association. This change was considered so important that it was voted on separately. The only other change in this article was the addition of a clause stating that the action of the association shall in all cases be recommendatory and not binding on its members.

In article II, on membership, the grade of "active member" is changed to simply "member." In the eligibility clause the word has been changed in several cases, without effecting any real change in the requirements for membership. Honorary members are to be exempt from the payment of dues. A clause has been added which defines the word "railway" as one "operated by steam or electricity as a common carrier dependent on transportation for its revenue." This clause provides that engineers of street railway systems and of railways which are used "primarily to transport materials or products of industries to and from a point on a railway which is a common carrier, or those which are merely adjuncts to such industries," shall be eligible only as associates. The clause referring to persons engaged in the sale or promotion of railway supplies is changed to read that "persons whose principal duties require them to be engaged" in such lines shall not be eligible for membership. It is further provided that any member who shall become subject to the operation of this clause shall, if he again becomes eligible, be admitted to membership without the payment of a second entrance fee.

In article III, on admissions and expulsions, the wording of the first clause was changed to take into account the fact that the charter membership is now completed. The provisions for election, reinstatement and expulsion remain practically the same.

No important change was made in article IV, on dues.

In article V, on officers, the number of directors is increased from 6 to 9, making it necessary to elect three directors at each annual convention instead of two as at present. The board of direction is made to include the last five instead of the last four living past presidents. A clause is added which requires candidates for president and vice-president to be selected from the members of the board of direction. It is provided that the office of president shall not be held twice by the same person, the former provision on this point being that a president should not be eligible for re-election to that office until a period of eight years had elapsed after the expiration of his previous term. Clauses were added which provide that a vice-presidency shall not be considered vacant when one of the vice-presidents is filling a vacancy in the presidency; that any vacancies for the unexpired term in the membership of the board of direction shall be filled by the board; that an incumbent of any office for an unexpired term shall be eligible for re-election to the office he is holding, with an exception applying to directors who were elected within six months after the term commenced; and that when an officer ceases to be a member of the association as otherwise provided his office shall be vacated and filled according to other provision.

In article VI, on nomination and election of officers, a nominating committee is created which shall consist of the five latest living past presidents and five members not officers who

are to be elected annually when the officers of the association are elected. It is the duty of this committee to nominate candidates to fill all offices and also vacancies in the nominating committee caused by expiration of term of service. The number of candidates to be nominated is specified, there being only one in the case of president, vice-president, treasurer and secretary; nine directors, of whom three are to be elected; and ten members of the nominating committee, of whom five are to be elected. It is further provided that the senior past president shall act as permanent chairman of the committee and issue calls for meetings. Nominees for offices are to be agreed on at a meeting held prior to December 1 of each year. The names of these nominees are to be announced by the permanent chairman to the president and secretary not later than December 15, and the secretary is to report to the members of the association on a printed slip not later than January 1 following. At any time between January 1 and February 1, any ten or more members may send to the secretary additional nominations. Not less than 30 days prior to the convention the secretary shall issue ballots to all members in good standing, who may erase names from the printed ballot and substitute other names, the number voted for not exceeding the number to be elected. Ballots are to be returned in a sealed envelope endorsed with the name of the voter before 12 o'clock noon on the second day of the annual convention, at which time three tellers are appointed to count the ballots. The persons receiving the highest number of votes for the respective offices are declared elected. In case of a tie the members present at the convention are to elect the officer by ballot from the candidates so tied.

In article VII, on management, a clause is added providing for the auditing of the accounts of the secretary and treasurer by a public accountant under the direction of the finance committee of the board of direction. A provision is made for special meetings of the board of direction, which shall be called on the written request of five members of the board. The board quorum is increased from 5 to 7. To the list of board committees is added one on "outline of work of standing committees," which is to consist of five members. The duties of the library committee are made to include the direction of expenditures for books and other articles of permanent value to be used in the offices of the secretary. The new committee on outline of work of standing committees is to present a list of subjects for committee work during the ensuing year at the first meeting of the board of direction after each annual convention. A clause is added to this article providing that an act of the board of direction which receives the express or implied sanction of the membership at an annual convention shall be deemed an act of the association and shall not afterwards be impeached by any member.

In article VIII, on meetings, the principal change is a provision for special meetings of the association to be called by the board on request of 30 members, who shall state the purpose of such meetings. The call for a special meeting shall be issued not less than ten days in advance and shall state the purpose and place thereof, and no other business shall be taken up at such meeting.

No essential changes are made in article IX, on amendments.

ASPHALTIC OILS FOR TIE PRESERVATION.*

The results obtained in the asphaltic crude oil treatment of railway ties by the Santa Fe and the National of Mexico have shown that waterproofing asphaltic crude oils have a claim for serious consideration as successful wood preservatives.

An investigation of the asphaltic crude oils located in sections of the country other than California or Mexico discloses the fact that, in their natural condition, the crude asphaltic oils foreign to these two localities are too volatile, highly inflammable, and not sufficiently viscous to prove of value as a wood preservative; therefore it is necessary to refine oils having an asphaltic base in other localities, thereby securing preservative oils which are similar and in some instances superior to the western asphaltic oils.

The attached table shows a complete analysis of three asphaltic oils, viz., the Western Bakersfield (Cal.) asphaltic crude oil now in use by the Santa Fe at Albuquerque, N. M.; the Mexican Ebano asphaltic oil, and finally the refined product of an asphaltic crude oil found in the central United States.

COMPARATIVE TESTS OF PRESERVATIVE OILS.

	Mexican Ebano.	California Bakersfield.	Central U. S. Timber-asphalt.
Flashes in closed tester (deg. Fahr.)	176	256	410
Flashes in open tester (deg. Fahr.)	190	268	470
Degrees Beaumé at 60 deg. Fahr.	12.1	11.9	19.2
Specific gravity at 60 deg. Fahr.	.9849	.9867	.9388
Distilling tests, using a retort (per cent. coming over):			
0 deg. C. to 100 deg. C. per cent.	....	....	....
100 deg. C. to 150 deg. C. per cent.	1.0	....	....
150 deg. C. to 300 deg. C. per cent.	20.1	15.0	....
Distilling tests, using flash thermometer opposite take-off:			
0 deg. C. to 100 deg. C.	....	....	....
100 deg. C. to 150 deg. C.	1.1	....	....
150 deg. C. to 300 deg. C.	22.6	16.0	23.5
Evaporation tests, placed in open dishes in air oven at 140 deg. Fahr.; oil 1.4 in. deep:			
In 24 hours, per cent.	6.8	2.3	....
In 96 hours, per cent.	9.4	4.6	....
Evaporation tests, placed in open dishes in air oven at 200 deg. Fahr.; oil 1 in. deep:			
In 24 hours, per cent.	9.8	4.8	.033
In 96 hours, per cent.	11.4	11.5	.132

Fractional Distillation (Standard Method).

	Creosote.	California Bakersfield.	Central U. S Timber-asphalt.
Specific gravity at 38 deg. C.	1.04	0.965	0.928
Below 210 deg.....Not more than 5 per cent.		0.50 water	0.333
210 deg. to 235 deg.....Not more than 25 per cent.		0.60 naphtha and water	0.50
235 deg. to 270 deg.		1.50 light oil	
270 deg. to 315 deg.		6.70 gasoline	34.166
315 deg. to 355 deg.		14.50 kerosene	
Residue		75.00 asphaltum	65.00
Spec. grav. of residuum at 38 deg. C.		0.99	

Note.—Bakersfield oil has been exposed in an open pan for one year and so far has shown practically no loss by evaporation.

Viscosity tests, using Scott's viscosimeter in which 200 C. C. oil is put in the viscosimeter and the number of seconds required to pass 50 C. C. through a small artifice is recorded. The standard for this machine is 11 seconds for 50 C. C. distilled water at 60 deg. Fahr.

Oil Heated to—	Mexican Ebano.	California Bakersfield.	Timber-asphalt.	Creosote.
100 deg. Fahr.	3,000	1,565	595	18
150 deg. Fahr.	339	238	115	16
200 deg. Fahr.	110	44.5	32	15
220 deg. Fahr.	70	31.5	23	11
250 deg. Fahr.	40.5	22	20	11

(Water 60 deg. Fahr.—11 seconds.)

During the month of April, 1910, various tests were made at the C. B. & Q. experimental plant at Galesburg, Ill., to thoroughly investigate the properties of a refined grade of an asphaltic crude oil as a wood preservative. Tests were run to determine whether this more economical oil could be used as a substitute for creosote oil in the card process. In these tests a mixture of 23 per cent. asphaltic oil and 77 per cent. of a 5 per cent. zinc chloride solution was used. The results from this experiment proved that asphaltic oils could not be used in the card process, because of the formation of a viscous emulsion, or saponification, which permitted the zinc chloride to penetrate the wood in large quantities but prevented the entrance of the asphaltic oil into the wood. The fact that the zinc solution separated from the emulsion and penetrated the wood, leaving a thick mass of oil and emulsion distributed either irregularly through the wood or on the exterior of the timber, proved the futility of trying this process further, especially as the

*From a paper presented by F. W. Cherrington at the annual meeting of the Wood Preservers' Association.

mixture was exceedingly hard to handle in the pumps and valves.

After determining the fact that the asphaltic residual oil could not be successfully used in the card process, additional test runs were made to determine with what degree of success the straight asphaltic oils could be injected into the wood, and finally a mixture of 75 per cent. of asphaltic oil to 25 per cent. of creosote.

The experiments at Galesburg demonstrated that fairly good penetration could be secured on the various oaks, elm, beech, gum, etc., ties when injecting all the preservative the ties would absorb. This maximum amount was found to be about 7 lbs. per cubic foot. Pine trees (short leaf) were found to readily absorb the straight asphaltic oil in good quantities with thorough penetration.

The treatment with 25 per cent. creosote to 75 per cent. asphaltic oil proved that the viscosity of the oil was greatly reduced by the addition of creosote, and about the same penetration and absorption could be obtained as with straight creosote with a greatly reduced cost of treatment.

In order to determine whether the same proportion of 25 per cent. creosote to 75 per cent. asphaltic oil existed in the tie after its injection, a sample of the borings extracted from several ties injected with this mixture was taken and analyzed by a competent chemist, which proved that the mixture remained in a stable and homogeneous combination.

From the results secured in the comparative analyses of the oil extracted from the borings of the treated ties, the original creosote oil and the original mixture of 25 per cent. creosote to 75 per cent. asphaltic residual oil, it is safe to state that the mixture found in the treated ties approached the original proportions, and that the mixture injected into the ties contained about the same proportion as the original mixture before injection; hence, the mixture of creosote and asphaltic residual oil remained in homogeneous solution before, during and after its injection into the wood.

In the fall of 1909 a large tank car of heavy asphaltic residual oil was shipped to the low-pressure plant of the Indianapolis, Columbus & Southern Traction Company at Columbus, Ind. At that time a co-operative agreement was entered into between the refining company to furnish the oil, the traction company to furnish the plant and ties, and the United States Forest Service to supervise the tests and to record the experimental data. This initial test at Columbus, Ind., proved a failure because of the inability of the small capacity pressure pump at the treating plant to handle the thick, viscous asphaltic residual oil which was at that time a grade very much heavier than the product which has eventually been adopted by the refining company as a more satisfactory material. Before this test was completed, however, it was found that the asphaltic oil resisted the forcing of zinc chloride solution through an injection of 3 lbs. of asphaltic oil per cubic foot to a very much greater degree than the same quantity of creosote. This proved the superior waterproofing quality of the asphaltic oil, as it is safe to assume that a material which would resist the forcing of a water solution through such a limited injection of 3 lbs. per cubic foot would successfully resist the action of water even under abnormal conditions to which treated material is generally subjected.

One other test made at the laboratory of the above-mentioned refiner may prove of interest in showing the additional waterproofing quality of the asphaltic oil. A paving block of standard size was treated with residual asphaltic oil to the amount of 16 lbs. per cubic foot. It was then dried in an oven of a temperature of 120 deg. Fahr. for a period of 24 hours, weighed and then immersed in clear water for a period of 24 hours. The gain in weight was found to be 0.02 of 1 per cent. The same block, if treated with 20 lbs. per cubic foot of creosote, would have been allowed to absorb as high as 3 or 4 per cent. of the water by weight.

The most recent test on asphaltic oils occurred in November, 1910, when several tank cars of asphaltic residual oil was shipped to the Mount Union plant of the Pennsylvania Railroad for a trial in the large cylinder at that plant. At this test three charges were run with straight asphaltic oil and three with a mixture of 33⅓ per cent. creosote to 66⅔ per cent. asphaltic oil. When this proportion of asphaltic oil and creosote was exhausted, more creosote oil was added as required until the proportion again assumed 100 per cent. creosote.

Sections sawed out of the center of the pine ties showed complete penetration through the sap wood to the heart, this being an equivalent penetration to that secured by the use of creosote.

It was found that the red oak, beech, elm and gum ties varied in the penetration secured, being dependent upon the amount of sap and heart wood in each tie. The penetration was not equivalent to that secured by creosote in all cases, but approached very nearly the results secured through the use of creosote. When the difference in viscosity between the two oils is considered this result is not remarkable.

In each of the straight asphaltic runs, eight ties were marked and weighed before treatment, being selected as average samples from among the 500 ties composing each charge, and placed in various positions in the cylinder. After the process of treatment had been completed the ties were again weighed and the absorption results of two charges with straight asphaltic oil secured.

The results secured on the mixture of creosote and asphaltic oils proved in every instance, as far as absorption per tie and the element of time for treatment may be concerned, equivalent to the results secured by the use of straight creosote oil. It must be admitted, however, that the asphaltic oils when used alone require a larger period of time for injecting an equivalent quantity of creosote, which quantity has been observed to be, in most cases, on hard woods, the maximum quantity.

Following these tests in the large cylinder, tests were made in the experimental cylinder on the Rueping process in the treatment of mixed oak and pine ties with straight asphaltic oil. The absorption obtained in the limited number of tests made on the Rueping process were very satisfactory, as the same penetration was secured by a limited quantity of oil as was secured by a larger quantity of oil in the straight asphaltic oil pressure process. This experimental test merely proved the applicability of asphaltic oils for use on a large scale in the Rueping process, although it is readily admitted that there are no long-time practical tests to emphasize the theoretical deduction that the treatment would be a good one. It is also readily admitted that the only value of asphaltic oil obtained from the central United States, as a wood preservative, would be in using a parallel treatment to that in which the Santa Fe has obtained such excellent results, viz., the injection of maximum quantity of oil into the wood. The only object in citing the experiment on the Rueping process is to show that the asphaltic oils are at least applicable.

As the distillation data in the table demonstrates that the fractions of asphaltic residual oil possess high boiling points, comparing in this respect very favorably with good coal-tar creosote and at the same time comparing favorably with the analysis of the Bakersfield oil, it seems reasonable to assume that it has great value as a wood preservative.

It has been claimed that if the asphaltic oils were injected in maximum quantities into the various specie of red oak, beech, elm, gum, etc., the quantity which would be

absorbed per tie would be so great that there could be no economy in its use. The attached data and the cross-section samples taken from the ties in the several tests made on these specie of wood with asphaltic residual oil prove that this is not the case. Good penetration has been secured by not over an 8 lb. per cubic foot injection of asphaltic oil, which also proved to be the average amount the various timbers would absorb.

This proves the case with all except the short leaf pine ties, and even with that species the amount of oil necessary to secure a maximum injection was not found to be prohibitive from the standpoint of economy.

The Santa Fe and the National of Mexico have demonstrated by a practical test, under abnormal conditions of about nine years' duration, the value of asphaltic oils when injected into pine ties to refusal. Some of the ties which successfully withstood this test contained a small amount of oil, yet it was in all cases the maximum quantity which the ties would absorb.

The foregoing data is the result of observations and experiments extending over several years with the asphaltic base oil to be found in such immense quantities throughout the central part of the United States.

TRACK ELEVATION AT NINETY-FIFTH STREET AND SOUTH CHICAGO AVENUE, SOUTH CHICAGO

In connection with the elimination of highway grade crossings which has been so vigorously prosecuted by the railways in Chicago for the past 15 years, there has been a very marked tendency for the roads to do away with grade crossings with each other wherever possible. While making the heavy expenditures necessary to get above the streets, the roads have decided in most cases to spend enough more to avoid the steam road crossings, with their expensive delays to traffic, which delays are continually becoming more serious as the business increases. From the very nature of the conditions, such double elimination of crossings is very costly, and introduces many complications, not the least of which is the handling of all construction work without delay to traffic. At no other point has the work assumed such magnitude or become so general as at Chicago.

A very good example of the problems met with is presented at Ninety-fifth street and South Chicago avenue, South Chicago, where work has recently been started. At this point the double-track main line of the Pittsburgh, Fort Wayne & Chicago and the three-track main line of the Lake Shore & Michigan Southern, running northwest and southeast, cross the single-track lines of the South Chicago branch of the Chicago, Rock Island & Pacific and the Chicago & Western Indiana belt railway running east and west. The Baltimore & Ohio double-track main line parallels the Lake Shore from the southeast to the crossing where it connects with the Rock Island, passenger and time freight trains using these tracks west for about 6 miles in entering the city. Freight trains on the Baltimore & Ohio other than time freights turn north at the crossing instead of connecting with the Rock Island and proceed to the Baltiomre & Ohio yard at Ninety-second street, where they are arranged for distribution in the city. After classification, Baltimore & Ohio transfer engines take them to the city by way of Ninety-fifth street and the Rock Island tracks. Just south of the crossing the Cummings branch of the Fort Wayne turns off to the south and extends into the manufacturing district on the north bank of the Calumet River. A similar line owned jointly by the Rock Island and the Belt railways turns off from these roads a short distance west of the crossings and, crossing the Fort Wayne branch about 700 feet south, runs parallel to it for some distance, connecting with the Irondale branch of the Rock Island,

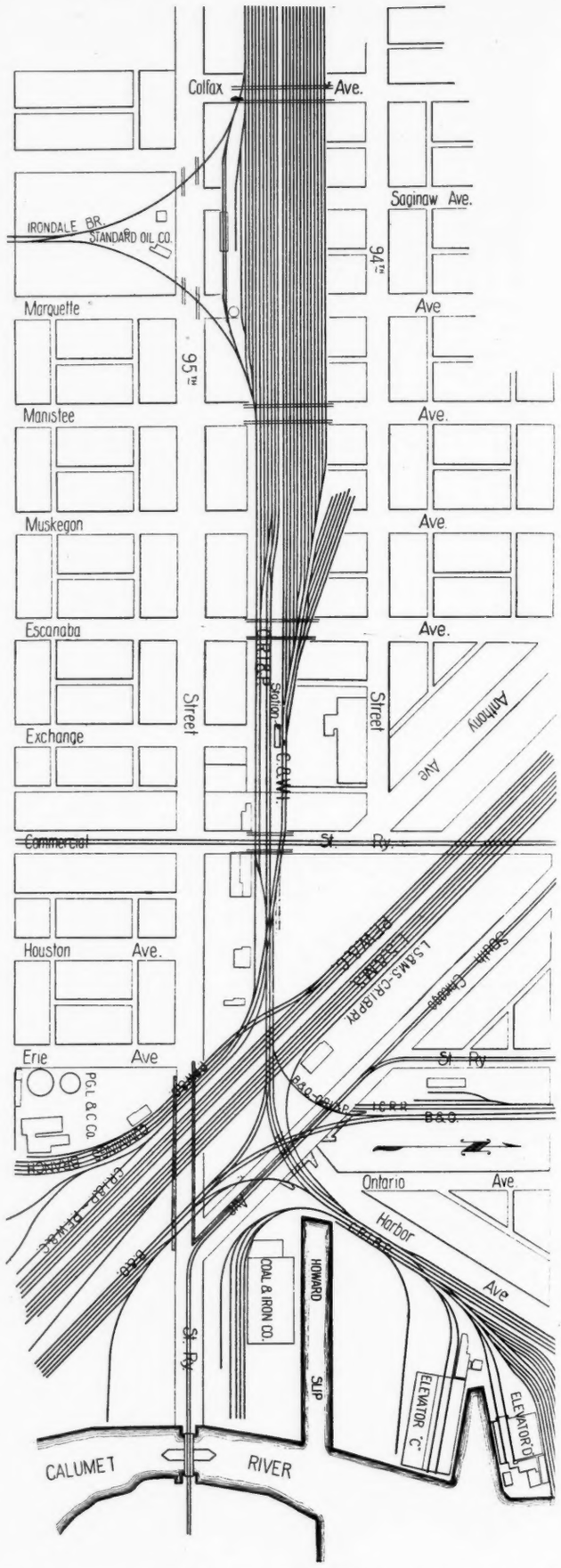


Fig. 1. Final Track Layout for Grade Separation at South Chicago.

which leaves that line about half a mile west of the crossings, and forming a loop. In addition, Y connections are maintained between the Rock Island and Fort Wayne, the Rock Island and Lake Shore and between the Baltimore & Ohio and the Rock Island on three sides.

All passenger and freight trains of the Fort Wayne and Lake Shore entering Chicago cross these crossings, as do all Baltimore & Ohio trains, freight trains passing over them twice, going to the Ninety-second street yard and then into the city. With the exception of the Baltimore & Ohio passenger trains, the Rock Island track is used for freight service only, this branch extending from a connection with the main line to the South Chicago industries, while the Belt railway is used exclusively for freight service. Both the Rock Island and Belt railways have transfer yards a short distance west of the crossing, that of the Belt containing 32 tracks. At these yards deliveries are received from eastern roads and the very heavy tonnage from the steel mills, elevators and other large industries of the Calumet district is classified. All business from this territory routed via the Rock Island is delivered directly to this road, which also receives that destined for the Illinois Central, delivering it to the latter road at Burnside, about three miles west of the crossing. An average of 20,000 cars per month is handled in this yard by the Rock Island. At certain seasons of the year traffic originating in this district equals that handled by the Rock Island in all the rest of Chicago combined. During the latter part of the month the grain business for the elevators is very heavy, often reaching 200 cars daily for its two elevators. The traffic handled by the Belt in its yard averages about 35,000 cars monthly, consisting almost entirely of transfer business.

Considering the amount of traffic handled in this territory, one would expect the number of train movements across this crossing to be very high. A record was kept for several days last Summer, and the total number of train movements of all kinds across these crossings reached over 500 during the daytime and nearly 400 at night, or a total of about 900 during the 24 hours. Of these there are 149 scheduled passenger trains, the maximum interval between the passenger trains during the daytime being 35 minutes, with a general average of about 7 minutes. As many of the freight trains are long and hold the crossings several minutes when passing, they are not permitted to proceed on the time of passenger trains, resulting in constant delays. These delays are especially heavy shortly before midnight, when the various roads are endeavoring to deliver their transfers to save the per diem charges.

The ordinance for this work was passed by the city council of Chicago on June 25, 1906, and required that all work should be completed before December 31, 1911, except that on the Rock Island and Belt railways west of Colfax avenue, which must be completed by December 31, 1916. In compliance with this and other ordinances the Fort Wayne and Lake Shore have already completed their elevation work from the city to the Indiana state line, with the exception of this one piece across the crossings and extending south about 2,000 feet across the Calumet River. The Baltimore & Ohio has also completed its work south of the river. Previous to last Fall neither the Rock Island nor the Belt railways had done anything on elevating their tracks. This ordinance provides for the elevation of their tracks from Jeffrey avenue east to include the crossings, or a distance of about 2 miles.

Preparation of plans for the entire project as far as it has effected the various roads at the crossings has been held up by the recent decision of the United States government to widen the Calumet River, necessitating a change in bridges

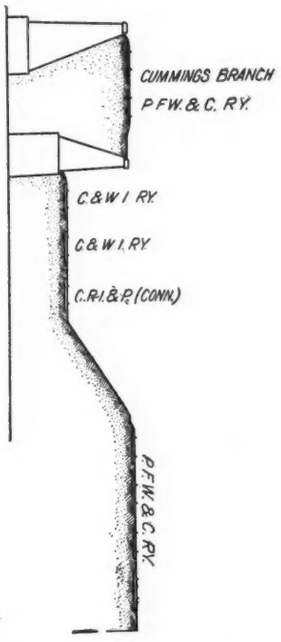


Fig. 3. Cross Section South of Crossing.

from those now in. Last December the government ordered the present bridges removed and submitted two options to the roads, defining the class of structures which would be satisfactory to it, one providing for two 90-foot clear openings with a center pier and the other for one 140-ft. clear opening. The roads have recently accepted the latter option and are now working on designs of these structures, but have not submitted plans to the government for approval.

While many of the detailed designs of walls and subways are not completed, the general plan has been definitely fixed by the ordinance and by agreement between the roads concrned. The Rock Island and Belt railways will start elevat-

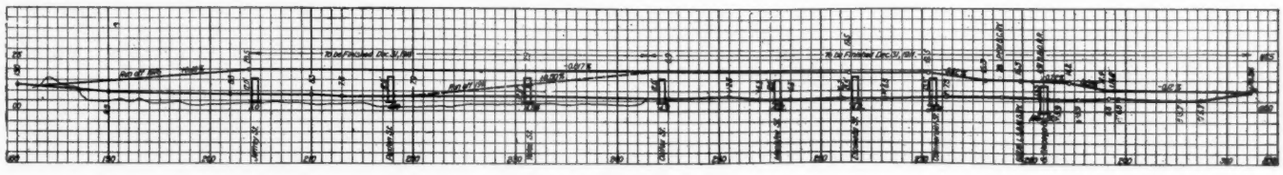


Fig. 2. Profiles of Chicago, Rock Island & Pacific and Chicago & Western Indiana Belt.

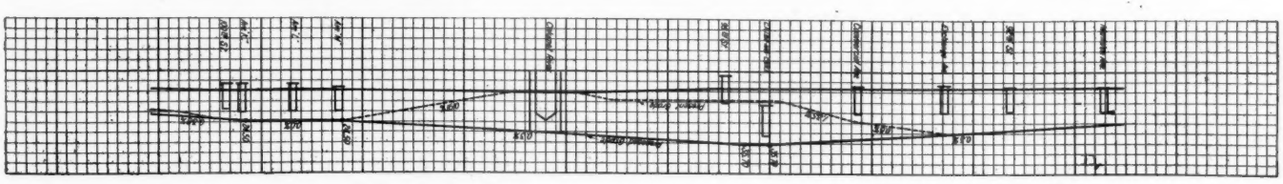


Fig. 2a. Profile of Pittsburg, Fort Wayne & Chicago and Lake Shore & Michigan Southern.

ing their tracks about 800 feet east of the crossing and rise to an elevation of 15.3 feet, Chicago City datum, at the crossings. Beyond this point they will rise to an elevation of 19.5 feet, about 15 feet above the old grade, and continue at this height to the limits of the work. The Baltimore & Ohio will cross the Calumet River at an elevation of 23.0 and Ninety-fifth street at an elevation of 17.8 feet and then descend on a 0.7 per cent. grade to the connection and crossings of the Rock Island. North of the crossing the grade will rise to an elevation of 20.5 feet at Ninety-third street subway. The Fort Wayne and the Lake Shore will cross the Rock Island and the Belt at an elevation of 35.7 feet, which, allowing for 3.4 foot depth of bridge floor, provides 17 feet clearance at the crossings. They will descend on each side on 0.3 per cent. grades, to connect with their previously completed work.

In planning for this work provision has been made for additional tracks. Five tracks in all are planned for the Lake Shore, while the Fort Wayne is providing for four. A double-track is to replace the present single-track of the Rock Island, while the Cummings branches of both the Fort Wayne and the Belt railways will be double-tracked. The Y connections between the various roads will be quite radically changed to fit the new conditions, the final layout being shown in Fig. 1. The present connection between the Lake Shore and the Rock Island (shown on Fig. 5) will be taken up and a new one built on a smaller radius and on a level grade until it crosess the Baltimore & Ohio-Rock Island connection, after which it will run parallel to the Lake Shore on a 1 per cent grade until it reaches the elevation of the main tracks. The three Baltimore & Ohio-Rock Island connections will be on nearly level grades. Due to the burning of a large elevator near the river on the east side of the Baltimore & Ohio tracks recently and the probability that it will not be rebuilt, the connection southeast of the crossing may not be built, as it was used only for this elevator business. Just west of the Fort Wayne tracks the most complications are introduced. The Rock Island-Fort Wayne connection will turn parallel to the Fort Wayne and then rise on an 0.8 per cent grade to the level of the Fort Wayne tracks. The double-track Fort Wayne Cummings branch will leave the main line just north of the crossings, instead of south as formerly, and continue at the main line elevation until it has crossed the Belt line Cummings branch as well as the main lines. In this way another grade crossing is entirely eliminated. Entrance to a boiler works and a gas plant a short distance south of the crossings complicate matters and tracks to these plants will be entirely rearranged. Just south of the crossing on the west side, the low tracks of the Rock Island-Fort Wayne connection and the Belt railway's double-track Cummings branch are between the high Fort Wayne main tracks and their Cummings branch tracks, presenting a cross section as shown in Fig. 3.

The agreement made by the roads provided that each road do the work under its own tracks except at the South Chicago avenue subway, where the Baltimore & Ohio will make the plans and do the work. The roads crossing at the lower level pay a proportion of the increased expenses incurred by the Fort Wayne and Lake Shore in crossing overhead.

Late last Fall the crossings were raised to the final grade of the lower tracks by the Rock Island and the Western Indiana, with temporary run-offs to the old grade. In raising these tracks across South Chicago avenue, the street had to be raised accordingly about 8 feet in order to maintain street

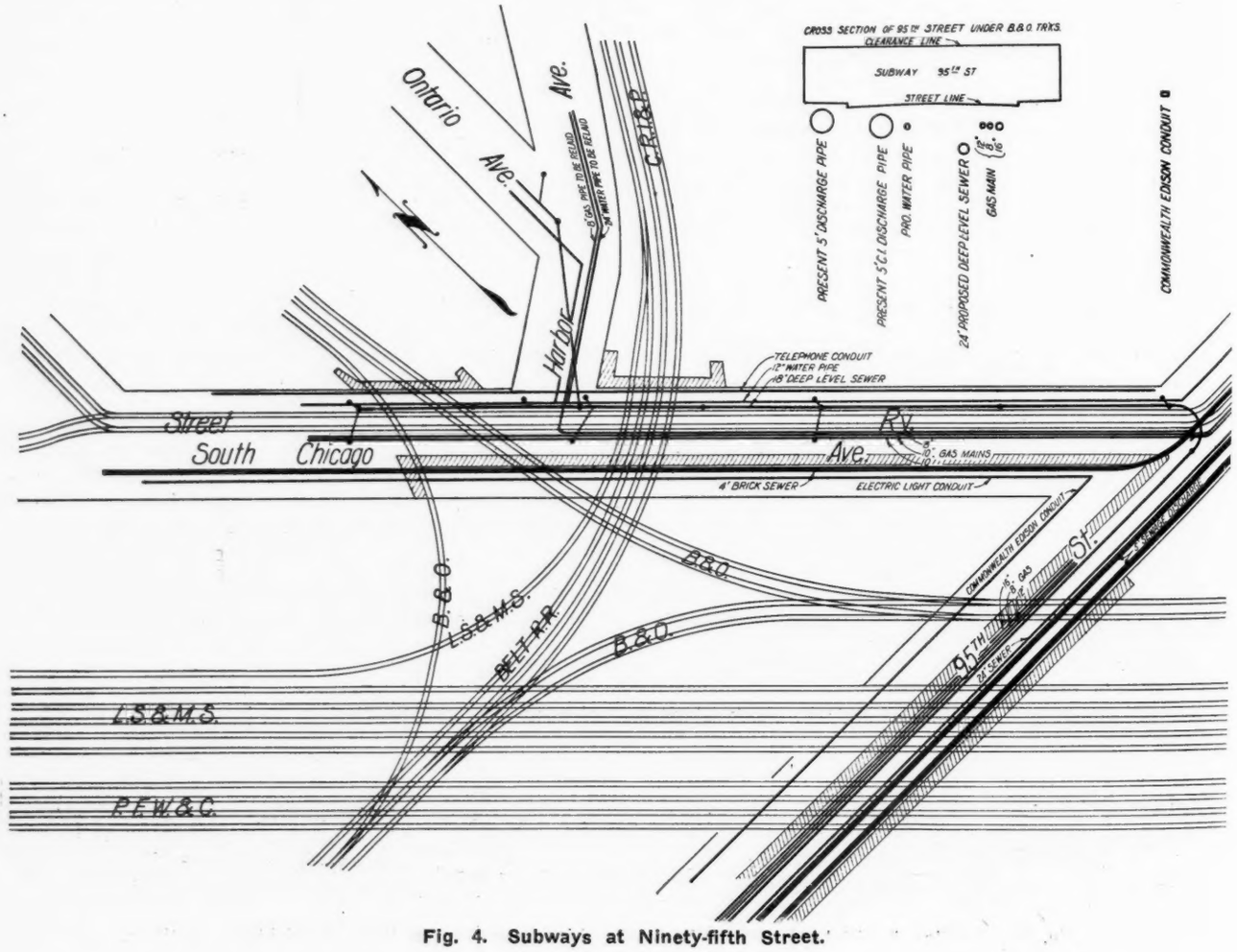


Fig. 4. Subways at Ninety-fifth Street.

car and team traffic. This year a subway will be built here and the street level lowered 7 feet below what it originally was.

The Rock Island has started work within the past month on their elevation west of the crossing. Six subways will be built with the standard clearance of 12 feet required by the city in all cases where there are no street cars, and 13½ feet where there are street cars. On several of these structures the subways will be of steel construction, with all the steel, including pillars, cross girders and I-beam floors, entirely encased in concrete.

The Rock Island will increase its present yard from 8 to 10 tracks this year and plans are made for 7 additional tracks. In elevating the yard the outside new tracks will be raised to grade, after which the other tracks will be raised by spreading from the adjacent high track. Temporary pile structures will be built across the streets, which will be left open and the permanent subways built after all the tracks are up. This year's work will require 350,000 cubic yards of filling, which will be brought in by contract. It is probable that the method followed last year, of bringing in sand over the Lake Shore from Dune park, the loading being done by contract and the unloading by company forces, will be followed. Because of the lightness of this sand, it will be covered with cinders as fast as the tracks are brought up to grade, to hold it down, except under the two main lines, where rock ballast will be used. In all, about 50,000 yards of cinders and 7,000 yards of crushed rock will be required for this work. For hauling

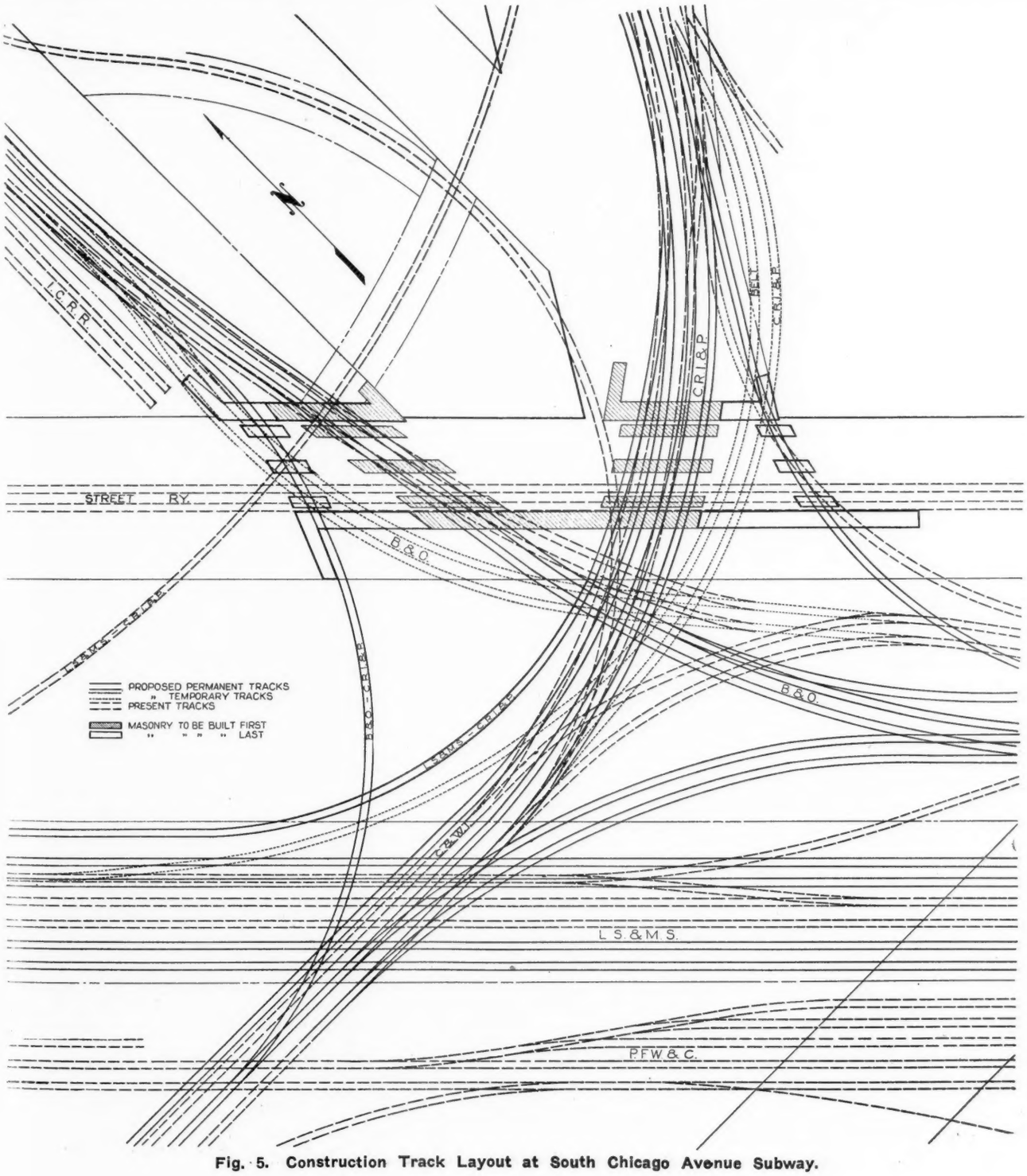


Fig. 5. Construction Track Layout at South Chicago Avenue Subway.

the sand 200 Hart convertible cars will be used. In addition, three freight locomotives, three switch engines, 40 flat cars and one spreader have been allotted to this work. One 10-ton locomotive crane with clam shell will be used to load cinders which have been stored during the winter.

The Rock Island's Irondale branch will be carried across Ninety-fifth street on the elevation, necessitating a subway under each leg of the Y. South of Ninety-fifth street the track will run down to the old level. In the Y and next to the yard tracks a four-stall frame engine house will be built for the use of the switch engines. An air hoist coaling plant, cinder pit, 115,000-gallon steel water tank, and three cranes will be installed. A new yardmasters' office will be built and a new depot is contemplated. East of the crossings the run-off built last year will be extended, requiring the raising of the tracks in the elevator yards to the doors of the elevators. In connection with this work the entire layout will be changed and rebuilt under traffic.

A very complicated problem is met with in the construction of the subways at Ninety-fifth street and South Chicago avenue, shown in Fig. 4. By agreement, the Baltimore & Ohio will construct all of the South Chicago avenue subway, while each road builds that part of the Ninety-fifth street subway under its own tracks. The opening at Ninety-fifth street is a new one, the street not having been used previously. A large part of the piling for the temporary structure at this street has already been driven and the excavation is well under way. The difficulties due to the various water and gas mains are indicated by Fig. 4. In driving piling under its tracks, the Baltimore & Ohio hit a gas main, emptying a large tank a short distance away in a few minutes. One 5-foot sewer had to be moved laterally 3½ feet to provide room for the base of a column and all the gas and water mains had to be lowered. The 48-inch sewer in South Chicago avenue, which turns into Ninety-fifth street, is so high that the oval top will have to be removed and a flat cover inserted to give the necessary clearance for a short distance in Ninety-fifth street.

In planning the construction of the subway on South Chicago avenue, estimates were prepared on two methods of handling the traffic during construction. One way was to follow the customary plan of driving piling and carrying the tracks on timber structures on their present location. The other was to lay temporary tracks on the bank to one side and then complete a part of the structure while the traffic was turned over to these temporary tracks. Estimates of the cost of the pile structures which would be necessary totaled $20,000, and of the temporary tracks, including seven new crossings, amounted to $7,000. In addition to the saving of $13,000 by using the latter plan, the interference with traffic would be very much less, and in driving piling there is the constant danger of hitting pipes and gas mains. The second plan was decided on. The temporary track arrangement, together with the order of building the subway, is shown in Fig. 5.

The ordinance provides that Harbor avenue be raised about 4 feet and paved for about 700 feet, descending into South Chicago avenue subway. As South Chicago avenue was raised about 8 feet last Fall, and now has to be lowered 7 feet the original level or to an elevation of minus 0.5, the excavation quantities will be large. It is planned to move the dirt with a steam shovel and small cars and use the material to fill Harbor avenue. After the first section of the subway is completed, the operation will be repeated on the balance. The floor of the subway being 0.5 feet below lake level, a new sewer must be built to drain it.

After the work is completed, grade crossings will still exist between the Rock Island and Belt and the Baltimore & Ohio freight tracks, and also between the two Y tracks northeast of the crossing. There will also be the junction of the Baltimore & Ohio tracks with the Rock Island. An interlocking plant is proposed for this, but no plans have been drawn.

We are indebted for the above information largely to the following officers, who are in charge of this work for their respective roads: J. B. Berry, chief engineer, and C. W. Petersen, engineer track elevation of the Chicago, Rock Island & Pacific; F. L. Stuart, chief engineer, L. G. Curtis, engineer maintenance of way, and F. G. Toeniges, engineer track elevation, Baltimore & Ohio; Thomas Rodd, chief engineer, R. Trimble, chief engineer maintenance of way, and D. M. Craig, engineer track elevation of the Pennsylvania's Northwest System.

WATER STATIONS FOR TRACK PANS.*

Track pans are primarily used to enable trains to take water while in motion. Their use up to the present time has been almost entirely confined to fast passenger trains making long runs between regular stops, but with increased efficiency from design of pans, methods of feeding and keeping water from freezing and improved scoops, the track pan is being adopted for freight trains, especially where it is desirable to keep trains moving, and in consideration of the excess cost of stopping and starting, the wear and tear of rolling equipment and the danger of breaking draft gear. The relative economy of the delivery of water to locomotives by the track pan and by the tank spout or standpipe is dependent from an operating standpoint upon: First cost, interest, depreciation, maintenance, operation, including cost of water, loss of energy expended in drawbar pull overcoming the dynamic pressure of water from pan or scoop, speed of trains, ruling grade, loss of time and cost of stopping and starting, including wear and tear on rolling equipment, etc. These factors will have a wide variance for different location and designs; hence each particular case should be figured separately.

The track pan should preferably be located on tangent, although it is possible to place same on curves up to three degrees and obtain fair results. The Pennsylvania and the Philadelphia & Reading have pans on two-degree curves which have proven satisfactory. The disadvantage of placing pans on curves, besides some additional first cost and cost of maintenance, are the difficulty of keeping pans in surface and some additional waste of water from spray and water washing over sides.

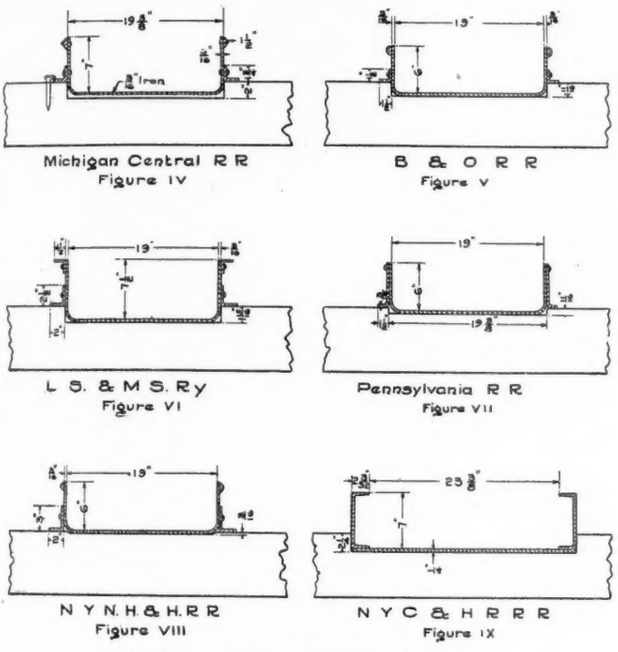
The pan should be laid on a level grade with grade of approaches such as to allow minimum speed required over pan to properly take water, and for this reason track pans should be away from stations, yards, railroad crossings, drawbridges, etc.

Pans are set directly on ties, the ties being dapped out about two inches and width of pan to form seat and allow top of pan to be the same elevation as top of rail. The pan is held in position and anchored by side lugs fastened to ties by ordinary or special form of spike or bolt with proper allowance for expansion and contraction of the material. The section of tie should be larger than ordinary and of white oak or other hard wood. On account of the large amount of waste water thrown over sides of pans, special attention should be given to drainage. The length of pan is one of the factors which determines the capacity. The economical length is dependent on the width of pan, size and adjustment of scoop, quantity of water to be taken into locomotive tanks during a given time and speed and time taken to fill pan. The length of the pan varies from 1,200 ft. on the Baltimore & Ohio to 2,000 ft. on the Lake Shore & Michigan Southern, with a width varying from 19 in. on the Baltimore & Ohio, New York, New Haven & Hartford and Lake Shore & Michigan Southern, to 23⅜ in. on the New York Central and 29 in. on the Pennsylvania. The depth varies from 6 to 7½ in.

*Appendix A, report of Committee on Water Service, presented at the annual meeting of the American Railway Engineering and Maintenance of Way Association.

The accompanying table shows the average number of gallons of water taken into locomotive tank with the corresponding number of gallons removed from tank and wasted per foot of length of pan by a scoop of cross-section 6½ in. by 12 in. and pans 19 in. and 29 in. wide for speeds of from 20 to 60 miles per hour.

The different pans in use at the present time are almost exclusively of built-up steel sections, although pans of cast-iron and wood have been used with less success. The type



Sections of Standard Track Pans.

of section is a matter of structural detail. The important considerations are rigidity, life and first cost. The depth should be 7 in. to 7½ in. so as to allow top of pan to be at same elevation as top of rail with a maximum dap in tie of not more than 2 in. to 2½ in. A width of 19 in. has been found to be the most efficient and economical for the operation of fast-speed trains and combined fast and slow-speed trains. The larger width of 29 in. has some advantage in the quantity water

Width of Pan (Inches)	Speed—M. P. H.	Number of Gallons Taken Into Locomotive Tank			Number of Gallons Taken Out of Track Pan = 100%			Per Cent of Waste
		Per Ft of Length of Pan	For Length of Pan= 1200 Ft	For Length of Pan= 2000 Ft.	Per Ft. of Length of Pan	For Length of Pan= 1200 Ft	For Length of Pan= 2000 Ft.	
19	20	1 70	2040	3400	2 10	2520	4200	.19
19	30	1.90	2280	3800	2 20	2640	4400	.14
19	40	2.00	2400	4000	2.20	2640	4400	.09
19	50	1 85	2220	3700	2.35	2820	4700	.21
19	60	1 70	2040	3400	2 80	3360	5600	39
29	20	2 20	2640	4400	2.90	3480	5800	24
29	30	2.30	2760	4600	2.90	3480	5800	21
29	40	1.90	2280	3800	2.65	3180	5300	.28
29	50	1.70	2040	3400	2.70	3240	5400	.37
29	60	1.50	1800	3000	3,00	3600	6000	50

Performance of Track Pans.

taken into locomotive tank per foot of length of pan for slow speeds, but this is partly offset by the additional waste. Figs. 4, 5, 6, 7, 8 and 9 show different sections of pans that have been found to meet the requirements. The end inclines should be substantially built to resist the larger amount of impact to which they are at times subjected by badly adjusted scoop, hanging under gear, etc. They should be built as a part of the body of pan forming ends. The rate of incline in direction of travel, in and out of pan, should not be more than ¾-in. to 1 ft. 0 in. of length and of perfectly smooth surface.

The size and number of supply pipes should be determined from the pressure, number of openings and minimum time required to fill pan. For expansion and contraction proper provision should be made in the form of corrugated or rubber hose, or by packed or special joints. The placing of pipes in cross tunnels at inlets allows the taking care of water run off from broken pipes, assists in drainage and facilitates repairs. There are two methods of regulating the filling of pans, viz.: (1) by man operation; (2) automatic valve. The latter method is generally the more dependable, and under average conditions should give the more economical and satisfactory result. The inlet should be so designed as to allow the minimum disturbance by flow of water into pan with corresponding minimum loss from friction. The deflector, enlargement of section of pipe at inlet and perforated plates are used at the present time.

To keep the temperature of water in pan below the freezing point or to raise the freezing point to avoid or remove the formation of ice at top of pan so that water can be taken during freezing temperature, the following methods are used:

(1) Blowing steam in water through nozzles in sides of pans spaced at intervals of 20 ft. to 30 ft. along length of pan.

(2) Circulating the water in pan by means of a pump and heater or an injector.

The results obtained by the steam heating method have been mostly satisfactory, but on account of the large amount

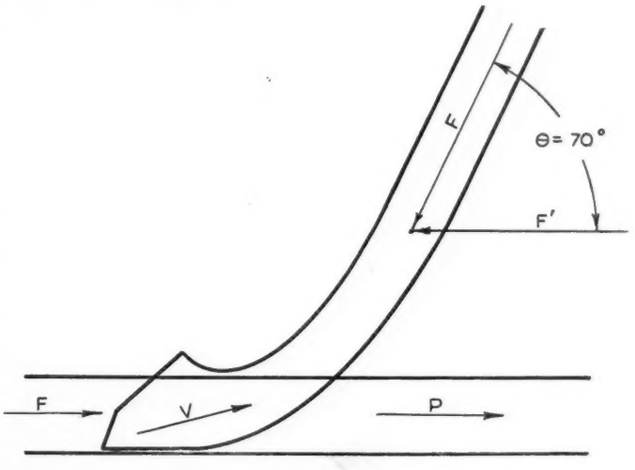


Fig. 1.

of energy expended and the number of connections, etc., to keep up there is a general tendency towards the use of the circulating method, although results obtained up to the present time have not been entirely satisfactory.

The action of the scoop while taking water from the pan is more or less as a blunt plow. At speeds above thirty miles per hour it is very apparent that the velocity of the water entering into the scoop is less than the velocity of the tender; this has the effect of throwing out of the pan, especially at higher speeds, the water on either side of the point of the scoop and between it and the sides of the pan. As the speed diminishes below thirty miles per hour a wave action is set up in front of the dipper, the water being piled up until it falls over the sides. This wave increases in size up to the point where the velocity imparted to it is less than that necessary to overcome the resistance due to gravity and friction, when, of course, no more water is lifted.

The dynamic pressure exerted by a surface moving in still water is equal to that produced by a stream flowing with the same velocity against a surface at rest. By the action of the scoop in the pan a dynamic pressure is produced in the oppo-

site direction to the motion of scoop, the resultant, of which, is counteracted by the drawbar pull.

Let F = Force of impulse in pounds.

Let F¹ = Component of F in direction of initial motion.

Let P = Dynamic pressure in pounds produced in direction of initial motion = Drawbar Pull.

Let W = Weight of water removed from pan per second.

Let V = Velocity of scoop in pan in feet per second.

Let G = Acceleration due to gravity = 32.2.

$$F = W \frac{v}{g} \quad \ldots\ldots\ldots\

mon to see a much lighter plate used under the switch than in the track adjacent. Light switch plates are now most commonly used, and but few of them; also, many roads have pressed-up risers in these light plates which more than half cut the plate in two right at a critical point under inner edge of the base of the stock rail, where light plates in any case soon become bent and broken. This is all wrong; the switch, especially on account of the moving rails, requires better support than the adjacent track, and there is more necessity for a solid shoulder tie plate under the switches than under the regular track.

Stock and switch rails having bearings on the heavy Ramapo riser plates throughout the length of the switch make an easy riding turnout and one that is easy to maintain in surface, while switch rails having vertical bends and light plates are not apt to get a bearing on every tie and may be found constantly working up and down excessively under every wheel on some of the ties, resulting in considerable wear on the plates and in all the fastenings.

LIGHT AND VENTILATION.

Light and ventilation in machine shops, power houses and factories are recognized industrial necessities. Artificial light is an important item in operating expenses; but work done under poor or insufficient daylight is extravagant. Naturally the more daylight we can utilize, the better both from the point of view of economy and efficiency.

The Detroit Fenestra solid steel window sash is an illustration of the tendency of the age to utilize every natural advantage. It is designed to provide sufficient strength to support the large area of glass that modern work shops require, and, by doing away with all heavy mullions and substituting the smallest steel sash, to increase immensely the light

Installation of Detroit Fenestra Solid Steel Sash.

space of the interior. With this type of structure, ventilation is easy and sufficient and may be arranged to suit almost any requirements by the use of the desired single unit or by a combination of unventilated sashes with those provided with ventilations.

Other strong features of the Fenestra installation are that it is fireproof and that the appearance of the sash is attractive, the natural curve at each joint relieving the monotony.

An exhibition at space 180 explains the construction of the Fenestra joint. W. F. Schmeltz, Detroit Steel Products Company, Detroit, Mich., is there with a display of lantern slides and photographs of recent railway installations, including the roundhouse at Frankfort and the shops at Galestown, Md., of the Pennsylvania Railroad and 17 views of the new Chicago & North Western buildings in Chicago.

HAYES DERAILS.

The Hayes Track Appliance Company is now building a new factory at Richmond, Ind., and expects to move from Geneva, N. Y., where it has been located, to the new headquarters in a short time. The rapidly growing business of this company, which is due directly to the excellent results that over 300 railways of the country are obtaining from the Hayes derails, requires a more centrally located distributing point and much larger manufacturing facilities than have heretofore been available. Both of these are going to be obtained in the new location.

Hayes derails are meeting with considerable favor in several foreign countries, where quite a number are being used particularly in South Africa and South America. This device has also recently been adopted as standard on a number of the leading railways of the United States.

The Hayes Track Appliance Company is exhibiting in space 140 at the Coliseum, and the exhibit is in charge of S. W. Hayes, W. Harding Davis, Wellington B. Lee, Arthur Gemunder, E. L. Ruby and S. W. Wallace.

INDIANAPOLIS MANGANESE PRODUCTS.

The same physical tests of manganese shown a year ago at the Coliseum by the Indianapolis Switch & Frog Company, were in evidence this week at spaces 12 and 13, but on a more elaborate scale, including not only their R-N-R type of solid manganese frogs, but also crossings.

The accompanying cut shows the distorting of one of their solid manganese pieces after having been subjected to 165 blows of a 1,200 lb. to 2,500 lb. weight dropped from heights varying from 3 ft. to 23 ft., aggregating 1,679,375 foot pounds.

Indianapolis Manganese Products.

The showing of an installation of R-N-R crossings and frogs in miniature demonstrated the riding of worn wheels over the entire layout without impact or pounding at joints or intersections and demonstrated the efficiency of this construction, which, together with its general line of manganese, is now in use on over 50 of the largest railway systems.

The general offices of the Indianapolis Switch & Frog Company are located at Springfield, Ohio, with sales offices at New York, Chicago, Richmond, Va., Kansas City, Spokane and San Francisco.

ALLITH HARDWARE DOOR EQUIPMENT.

Among the devices of the Allith Manufacturing Company, Chicago, which are meeting with favor is the Allith parallel door equipment, which has been in service at freight stations and warehouses for a number of years and has recently been successfully applied to engine-house doors.

The Allith fire and warehouse door hardware for inside or outside sliding doors or shutters, for fire wall or other openings, are also meeting with favor. They are simple and easy to install, and service tests of long duration have proved that they and their attachments are strong and durable. This fire door hardware is regularly inspected and

labeled under the supervision of the Underwriters' Laboratories, Inc., under the direction of the National Board of Fire Underwriters.

The Allith Manufacturing Company is planning the moving of its factories from Chicago to Albion, Mich. This company has just recently bought the plant, equipment, business and good-will of the T. C. Prouty Company of Albion, Mich.

The Allith exhibit, space 116, is in charge of W. D. Jameson, who for the past eight years has been at the head of the railway department.

D. & A. CEMENT POSTS ON THE C. & N. W.

One of the first railways to manufacture and use reinforced concrete fence posts was the Chicago & North-Western, which purchased equipment for the manufacture of these posts in quantities in the fall of 1908. Posts made at Dunlap, Iowa, have been set along the lines in western Iowa, and, after being in the ground with fences attached, are reported in perfect condition.

The D. & A. machine, which is in use at this point, consists of ten individual U-shaped steel molds, grouped on a frame called a "shaker," which holds the molds up from the ground about two feet, making them readily accessible for filling. The insides of the molds are greased slightly with some thin oil, and the concrete is then shoveled, or dropped from a mixer, filling the ten molds level full at one time.

For the reinforcement, hoop steel is recommended, as it has large surfaces for bonding with the concrete and is easily and quickly placed in definite positions by the use of a placing device, furnished with the outfits. For line posts, four of these reinforcing strips are used, placed about ¼ in. from the surface of the concrete. Concrete of about the consistency of mortar for plastering houses is used, and when the lower two reinforcements are placed the bed of molds is vibrated horizontally on the springs of the supporting frame, or shaker, for ten to fifteen seconds. This settles the concrete in all ten molds at one time evenly and thoroughly, in less time than one post could be tamped. This shaking not only settles the concretee, but gives a better bond to the reinforcement, so that no deformed or corrugated or twisted reinforcement is necessary. As the shaking continues, bubbles of air and the surplus water rise to the top or face of the post, making the initial set of the cement take place more quickly than if a surplus of water remained in the concrete. After shaking, the upper reinforcements are placed just beneath the surface of the post, and the molds refilled if necessary, owing to the steeling of the concrete. The flat faces of the posts are troweled level.

The filled molds are then transferred individually from the frame to soft, level ground, the square ends holding them upright, where they are allowed to remain to take the initial setting, which takes from 6 to 24 hours, according to weather conditions. Then the molds are rolled half over, the large ends removed, allowing the sides of the mold to spring slightly away from the post, and the molds lifted off. The posts ar allowed to remain with the flat side on the ground to season for several days, when they may be piled on end if desired, to economize space. It is preferable to sprinkle the posts while lying on the ground, and also after standing on end, and in many instances they are covered for a couple of weeks so that they will not dry out.

Being heavier than wooden posts, the cost of setting concrete posts is about 25 per cent higher than for wooden posts, but, once set, they are permanent and require less attention and repairs. They are all of uniform size, shape, color and length, and make a neat and sanitary fence.

Steam curing may be employed if desired, and instead of transferring the filled molds from the shaker to the ground, they can be transferred to curing cars. The molds can be racked one layer over another on cars holding from 30 to 50 posts each, and run into steam curing chambers, similar to dry kilns for wood. In one week, or less, they are sufficiently seasoned for setting in fencing.

The D. & A. machine used by the C. & N. W. at this point is manufactured by the D. & A. Post Mold Company, Three Rivers, Mich. One of these 10-mold machines is on exhibition at the Railway Appliances exhibition. The company also shows a steam curing unit consisting of steam car and 30 molds, manufactured posts, reinforcements, anchor posts, anchor molds, etc.

The mold for telephone and telegraph poles is being shown for the first time, and the method of reinforcement is worth considerable attention, owing to its simplicity and durability. The first cost of concrete poles does not exceed that of wooden poles of the same lengths, and in the larger sizes and lengths there is a saving in favor of the concrete poles. The company has recently made up whistling post molds, suitable also for mile posts, for one of the leading railways, using the regular fence-post molds.

In addition to the C. & N. W., the following companies are now using D. & A. molds and machines: P. C. C. & St. L., Mo. Pac., Mich. Cent., Clev., Ak. & Col., M. R. & B. T., D. L. & W., E. & P. and P. F. W. & C.

The D. & A. company is putting out a neat illustrated catalog entitled, Concrete Posts and How to Make Them, which quite fully describes and illustrates the shaking system, accompanied by quotations and estimates of the cost of concrete posts.

CONSTRUCTION WORK ON THE OREGON TRUNK.

An officer of the Oregon Trunk Railway writes that there is no immediate prospect of building this line south of Bend, Ore. Track already has been laid on 115 miles, from Fallbridge, Wash., to Metolius, Ore. No further contracts will be let at present. The grading work on the first 110 miles from Fallbridge was carried out by Porter Brothers, Portland, Ore., and from that point to Bend, 46 miles, by H. C. Henry & Co., Seattle, Wash. The first 110 miles follows the Des Chutes and Willow creek canyons; the work on this section was extremely heavy, being practically all through solid rock. The remaining 46 miles to Bend is through a scab rock country, requiring an even number of cuts and fills. The material handled was mostly rock. The roadbed has been graded to Bend. Maximum curvature, Fallbridge to Madras, Ore., 6 degrees; Madras to Bend, 3 degrees. Maximum grade, Fallbridge to Metolius, 0.6 per cent., with 20 miles of 1.3 per cent. pusher grade from Mecca to Metolius. This grade is all ascending toward Metolius. Maximum grade from Metolius to Bend is 1 per cent. against southbound and 0.5 per cent. against northbound trains.

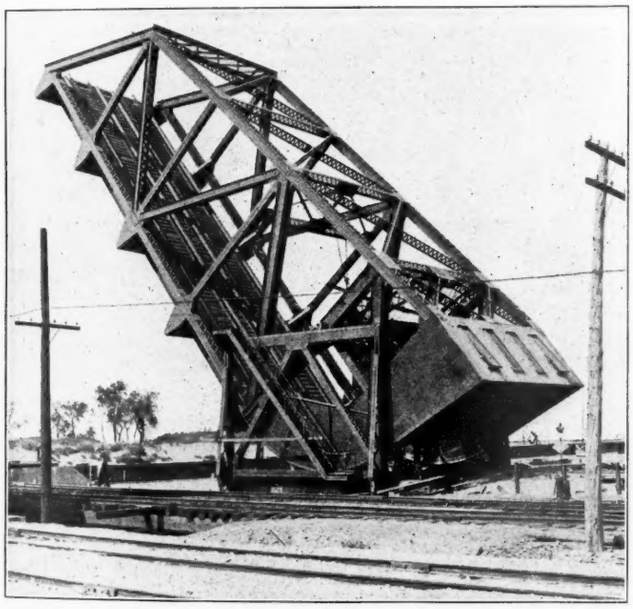
There will be a steel bridge over the Columbia river 2,427 ft. 8 in. long with approaches of 1,734 ft.; also one at the first crossing of the Des Chutes river, 465 ft. long, and another at the second crossing, 510 ft. long. Steel bridges will also be built over the White river, Wapinitia creek, Nena creek, Eagle creek, third crossing of the Des Chutes river, and over Trout creek, varying in length from 112 ft. to 175 ft., also a steel bridge over Crooked river, 460 ft. long. There is also a large amount of trestle work. The steel bridges, including substructures, have all been designed and are being constructed under the direction of Ralph Modjeski. A terminal yard, including fuel, oil and engine house facilities, is being built at Fallbridge, and a freight terminal is under construction at Metolius. The principal commodities to be carried on the line are: wheat, live stock and lumber from central Oregon, and merchandise and manufactured goods to that territory.

SCHERZER ROLLING LIFT BRIDGE AT INDIANA HARBOR.

In order to develop the industrial and manufacturing possibilities of the vacant lands between South Chicago and Gary, the East Chicago Canal Company was organized to build a canal from Lake Michigan, at Indiana Harbor, extending inland to a junction with the Calumet river at Hammond, Ind. The canal company negotiated with the railways entering Chicago from the southeast for building movable bridges to accommodate the passage of large lake vessels in the canal.

During the past three years a number of movable bridges have been completed across this canal, including three Scherzer rolling lift bridges, as follows: One double-track bridge for the Chicago, Lake Shore & Eastern, one double-track bridge for the Lake Shore & Michigan Southern, and a single-track bridge for the Elgin, Joliet & Eastern. The accompanying illustration shows the Chicago, Lake Shore & Eastern bridge, being the first structure crossing the canal adjacent to the lake.

This bridge, which is a single-leaf through-truss standard railway bridge of the Scherzer type, has a span length



Scherzer Rolling Lift Bridge at Indiana Harbor.

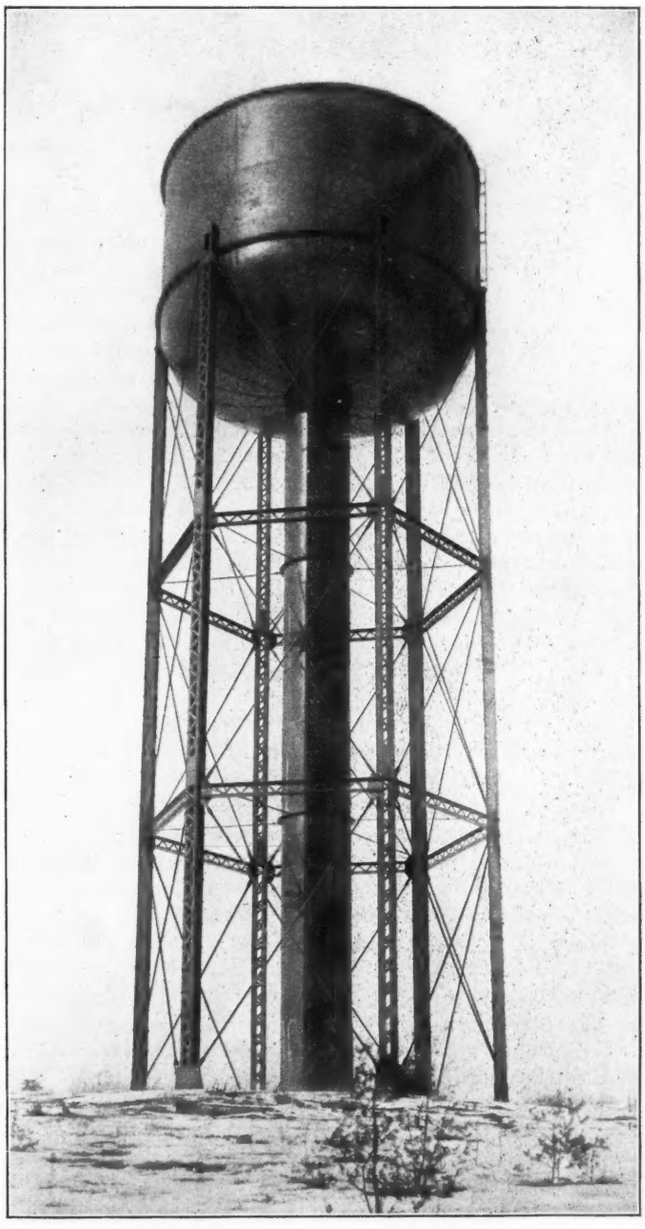
of 86 ft. 6 in. center to center of bearings, with a width of 30 ft. center to center of trusses. The counterweight is concrete, placed in a steel box running across between the trusses, to which it is rigidly attached, forming a substantial and economical bracing and making the entire moving leaf one simple, rigid and self-contained structure. This combination of steel and counterweight in one piece without links and flexible connections is one of the special advantages of the Scherzer rolling lift bridge, and makes possible its economical adaptation to many varying conditions.

The operating machinery and equipment is also simple and effective. Power for operation is obtained from two 25 h. p. direct current electric motors located on the moving leaf in front of the counterweight box, the motors driving pinions which engage with fixed racks outside of the plane of each truss. Only a small part of the capacity of the motors is required in operating the bridge under ordinary conditions, as the moving leaf is in balance in all positions. Hand power may be used for operation should the current be cut off, or the operating equipment be out of service. The operator's house contains, in addition to the motor control, a simple but complete arrangement to enable the operator to know the position of the bridge at all times during operation, both day and night. The operating equipment is interlocked with the front lock holding the bridge in its closed position and with the railway signals, so that the lock cannot be drawn and the bridge operated until the railway signals are set.

The bridge was designed and built under the direction of Arthur Montzheimer, chief engineer of the Chicago, Lake Shore & Eastern, the design of the bascule span being prepared by the Scherzer Rolling Lift Bridge Company, Chicago. The steel work was fabricated by the Lassig plant of the American Bridge Company, F. W. Denser, engineer, and erected by the Pittsburgh Construction Company.

WATER TANKS.

The exhibit of the Kennicott Company of Chicago Heights, Ill., in Booth 16 contains, in addition to the model water softener, photographs of steel storage tanks for railways and cities. A recent installation is an elliptical bottom tank for the Northern Pacific at Brainerd, Minn., a photo-

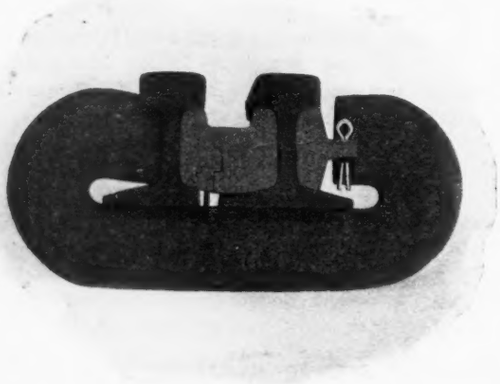


Kennicott Steel Water Tank at Brainerd, Minn.

graph of which is shown herewith. The Harriman Lines have sixty-five Kennicott tanks on their system.

WHARTON GUARD RAIL CLAMP.

The clamp in the exhibit of Wm. Wharton Jr. & Co., Inc., Philadelphia, Pa., is one that was brought out a number of years ago by this company. The yoke is the same as was used in the original clamp, but improvements have



Wharton Guard Rail Clamp.

been made in both the fillers and the wedge. The clamp has been found to be most effective.

SPIRAL SWITCH GUARD.

The general construction of the spiral switch guard, or bar, is the same as the motion-plate detector bar in general use, but its motion in operation is that of a spiral instead of an inclined plane. The form of the motion plate is such that the guard or bar is caused to advance along the side of the rail and at the same time and by the same movement pass upward and over the top of the rail. If an attempt is made to move the bar at the time there is on the rail a wheel whose flange projects beyond the head of the rail, the motion of the guard or bar will be arrested as soon as it comes in contact with the wheel tread. If, however, owing to excessive width of gage on account of worn wheels and rails, the outer face of the wheel does not project beyond the rail, the spiral motion of the guard or bar will bring it in contact with the face of the wheel and the further motion of the bar will be prevented. This guard is made by the Union Switch & Signal Company, Swissvale, Pa.

WATERPROOFING CONCRETE SLAB BRIDGE FLOORS.

Concrete slab subways are rapidly coming into more general use in track elevation work. This form of construction is at present more extensively used in those cities where the regulations do not absolutely require a clear span over the entire street and sidewalks.

This type of subway possesses many advantages in the way of permanence and low maintenance charges, and calls for permanent protection in the way of waterproofing at the time of original construction. The requirements for waterproofing are usually twofold, the city regulations generally demanding this protection for users of the subway, and railway engineers being fully alive to the necessity of protecting the structure itself by the exclusion of moisture. Unless the structure is waterproofed, the reinforcing steel is liable to corrosion; and the presence of moisture in the concrete under the action of frost, causing the concrete to cap and shell on the underside of the slab, will in turn expose the reinforcing rods.

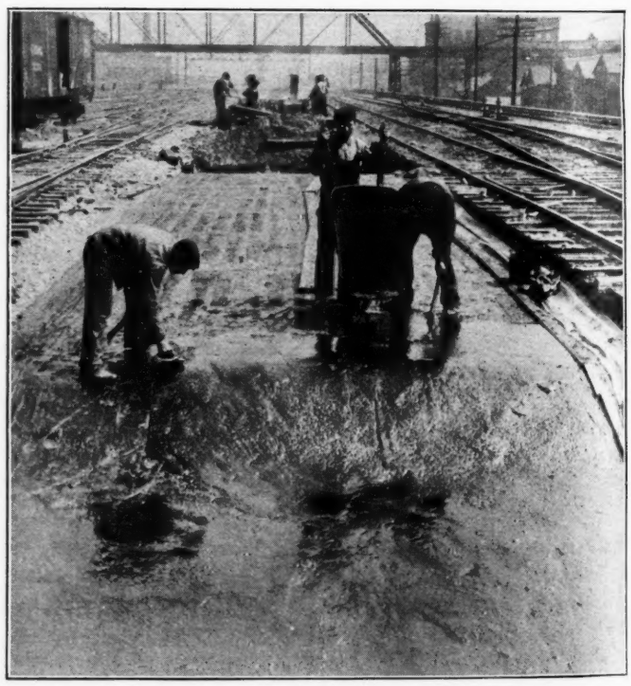
The accompanying cut shows clearly the Sarco method of waterproofing this type of structure. The work illustrated is that on the Sixteenth street, Chicago, track elevation of the Chicago, Burlington & Quincy. The mastic layers are shown in the act of placing the mastic protection over the waterproof membrane on the slope at the juncture of the deep, or street, slabs and the shallow slabs over the sidewalk. The concrete slope is placed after the street and sidewalk slabs are set and should have a system of anchorage to one or the other of these slabs and a grade of not less than 1 to 3. The work in this case consists of Sarco No. 6 waterproofing, reinforced with open mesh burlap in five-ply, and protected with a 1¼ in. coating of sand mastic, consisting of Sarco No. 6 waterproofing and sand in the proportion of 1 to 4 by volume. A general specification for this class of work is as follows:

On the clean and dry surface of the concrete floor, fascia walls and end walls of the bridge there shall first be applied, with brushes, a coating of Sarco concrete primer, which coating as applied shall be thin enough to penetrate the recesses of the concrete, forming an anchorage for the subsequent waterproof coating.

After this priming coat has been allowed to dry there shall then be applied, with mops, a heavy coating of Sarco No. 6 waterproofing, which has been heated to a temperature of 400 deg. Fahr., and while the material is still hot there shall be introduced a layer of 8-oz. open mesh burlap, all carefully laid down and free from folds and pockets. The surface of this burlap shall then be heavily swabbed with Sarco No. 6 waterproofing and two more ply of 8-oz. open mesh burlap laid in the same manner, making a 3-ply burlap mat, all thoroughly saturated, cemented and bonded together and to the concrete with Sarco No. 6 waterproofing.

On this waterproof mat there shall then be laid one layer of Sarco asphalt felt and the edges lapped at least 3 in. and sealed with Sarco No. 6 waterproofing.

The surface of the felt shall then be covered with 1½ in. thickness of Sarco mastic laid in 2-ply with lapped joints, and the



Sarco Method of Waterproofing Concrete Slab Bridge Floors.

same carried up the side walls to the ballast line to protect the waterproof mat from puncture by the rock ballast. The surface of this mastic shall then be heavily swabbed with Sarco No. 6 waterproofing and given a sand finish while the material is still hot.

The Sarco mastic as laid shall be worked evenly in convenient widths, and the two layers lapped at least 12 in. It shall be spread to the required thickness with wooden spreaders and floats, the thickness being gauged by ⅝ in. strips held in position by proper weights, and enough pressure applied to the mastic to eliminate all voids and blow holes, making a homogeneous mass throughout.

Before the Sarco mastic has been applied on the bridge floor there shall be laid over the concrete end walls a burlap curtain in 3-ply, which shall extend down over the black walls for 3 ft. This burlap curtain shall be thoroughly saturated, cemented and bonded together, and to the concrete with Sarco No. 6 waterproofing.

At the bottom of this burlap curtain there shall then be laid a

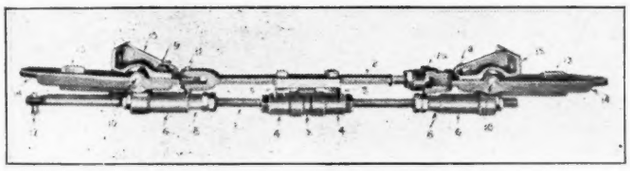
line of 6-in. farm tile, and back filled with cinders or quarry chips to provide a drain for the water from the bridge floor and the fill, and to prevent seepage through the concrete back walls on to the bridge seats.

The critical points in this waterproofing work are the handling of the membrane over the slope and the tying in of the same with the adjoining track work. These subways are sometimes 10 and 15 tracks wide; and the waterproofing must of necessity be made continuous, or fail entirely in its purpose. Great care must be exercised in handling the work at these points, and a special system of tying be adopted.

This membrane method of waterproofing has already shown in service its adaptability to this type of permanent subway construction, and is an example of one of the successful methods developed by the railway and waterproofing department of the Standard Asphalt & Rubber Company, Chicago.

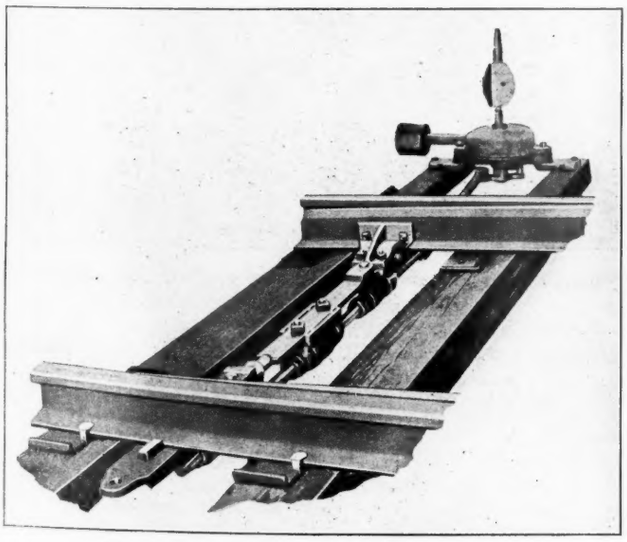
NICKERSON SINGLE-LEVER SAFETY SWITCH LOCK.

The Nickerson single-lever safety switch lock, made by the W. F. Bossert Manufacturing Company, Utica, N. Y., is designed to solve the problem, which every signal and maintenance of way engineer has found a troublesome one, of locking switch points at noninterlocked switches. This



Nickerson Adjustable Head Rod.

is a difficult matter, and many attempts have been made to devise a lock which would hold the points. The Nickerson device is designed to take advantage of the slight loss of motion which exists between the switch lever and the switch points. In this apparatus a locking bar is arranged to project upward through a slot in the base plate outside

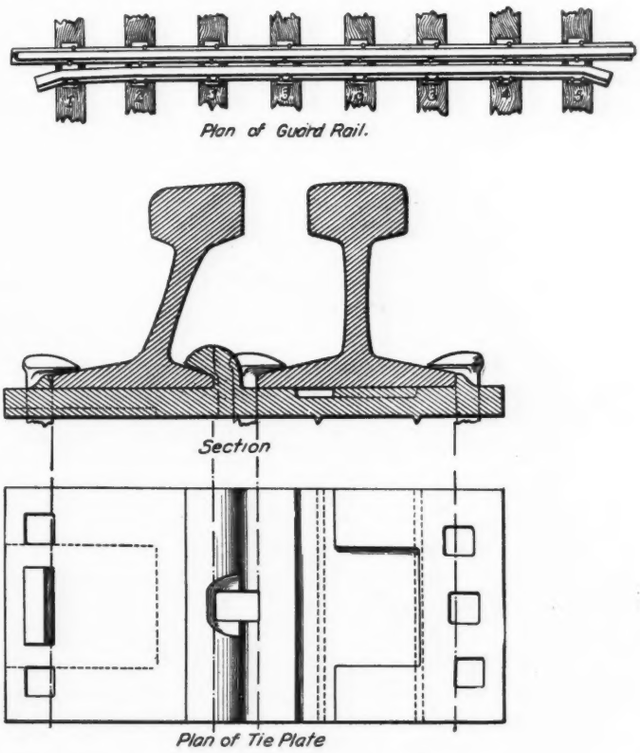


Nickerson Single Lever Safety Switch Lock.

of each stock-rail, thereby holding the switch point firmly to the stock rail. The arrangement is such that the locking bar locks only the point that is in the closed position against the stock rail. The switch lever and an adjusting rod give motion to the locking bar, which depresses it and unlocks the switch-point just an instant before the points begin to move. Then when the points are in the reverse position the last part of the movement of the switch lever and adjusting rod operates to push the locking bar upward through the slot in the base plate and locks the other point against the stock-rail. This device is extremely simple. It can be put on any switch and furnishes an effective lock which holds the points at the one place where effective protection is necessary. The safety switch lock can be attached to any ordinary switch-stand, and at a slight increase of cost can be connected with either the target of the switch-stand or with the home or distant signal, so that these will indicate when the points are unlocked.

MORRISON GUARD RAIL.

The Cambria Steel Company, Johnstown, Pa., is exhibiting in space 177 at the Coliseum its Morrison guard rail. The theory underlying the design of this guard rail is the same as that which accounts for the outer rail of a curve not overturning under a fast-moving train; that is, the wheel load on the main rail is greater than the centrifugal force or lateral thrust of this same load. This was demonstrated in practice by an accident on an eastern road, where a large freight engine with a loose driving wheel entered a yard lead from the main track. The loose



Morrison Guard Rail.

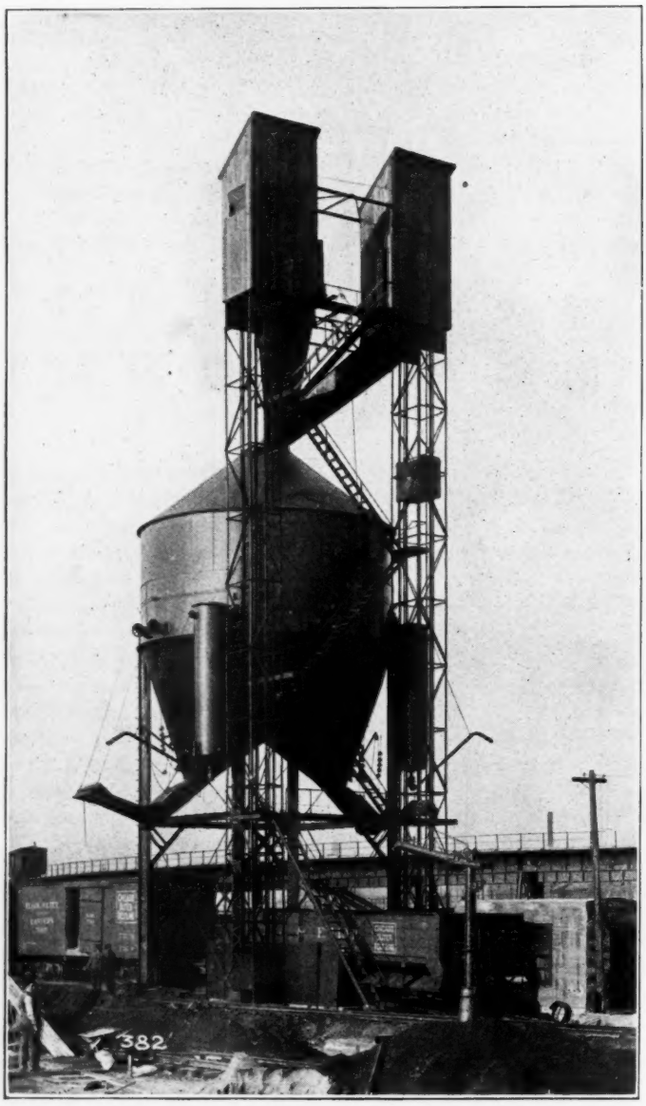
wheel dropped inside the rail and ran over four common guard rails, which alternated with three Morrison guard rails. The common guard rails were forced over on their sides, while the Morrison guard rails were not disturbed, and no damage was done further than the cutting of a groove in the rail where the driver struck it and mounted. The wheel load exerted no controlling influence on the common guard rail, but it gave stability to the whole Morrison guard rail structure.

There are two forces acting on a guard rail—vertical or overturning and horizontal. The former is controlled by the 6-in. lug on the tie plate, which engages the guard rail at a point farthest removed from the fulcrum point, and the latter by a shoulder on the plate engaging the outer base

of the guard rail. The spikes merely hold the outer base of the guard rail down to place. The guard rail is adjustable for wear by moving it and the plates closer to the main rail and spiking in one of the staggered holes at the outer edge of the main rail, in this way obtaining several times longer service than obtained from a common guard rail.

STEEL COALING STATIONS.

The 300-ton all-steel coaling station recently built at Gary, Ind., by the Elgin, Joliet & Eastern, is of interest since it shows the present tendency toward the use of steel in the building of coaling stations. When wood is



Steel Coaling Station at Gary, Ind.

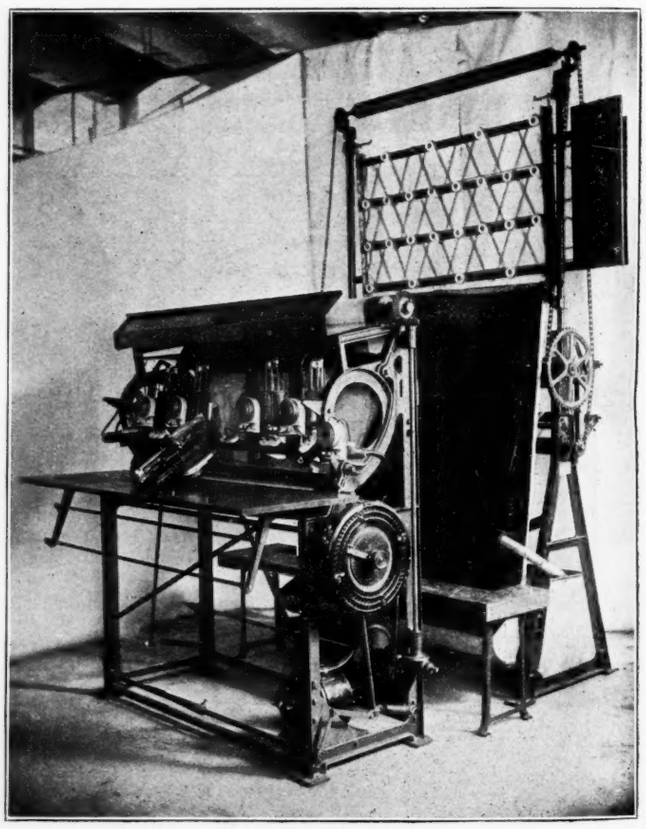
used for such a purpose there is great danger of fire from both engine sparks and spontaneous combustion. While for stations or less than 200 tons capacity wood has the advantage of lower first cost, yet for stations of larger capacity even this temporary advantage is largely lost. The station shown serves the two outside tracks, while the hopper track runs between the posts which support the tank.

This station is one of the number which have been recently designed by the Otto Gas Engine Works, Chicago, and for which the steel has been furnished by the Chicago Bridge & Iron Works, Chicago.

WHITE PRINTS vs. BLUE PRINTS.

The advantages of white prints, or prints with sharp blue lines on clear white background, are apparent, but up to quite recently white prints had to be made by the negative process, and the uncertainty of the results and the time and expense involved, have prevented their use in any considerable quantity.

The C. F. Pease Company, Chicago, recently invented a process and apparatus for making white prints direct from the tracing automatically, without the use of a negative. These white prints are regularly made on high-grade parchment paper, but it is possible to use paper of the same grade as that used for ordinary blue prints, and by the Pease automatic process the original whiteness of the paper is retained, while the blue lines produced are sharp and clear. These prints can be made up to 54 in. wide, and any length, in one piece. The prints as they come from the automatic machine are almost without



Pease Printing, Washing and Drying Machine, with Electric Dryer.

shrinkage, and have fast color, the strongest sunlight having no effect on them.

The company furnishes a special eradicator and a special blue ink by the use of which alterations and additions can be made on white prints without defacing the print. For reproducing proposals, reports, contracts, tabulations, etc., satisfactory copy for this machine can be made by typewriting the material on transparent paper, using a black ribbon and backing up the sheet with a fresh black carbon. In this manner any number of clear and distinct copies on white paper can be made.

The C. F. Pease Company operates a large plant in Chicago, where they receive tracings from all over the United States for printing. The company also manufactures and sells the machines with which the direct white prints are made, and a number are now in use by railways and

manufacturers. The accompanying illustration shows the Pease peerless printer, coupled up with the Pease automatic washing and drying machine.

This company is also making a combination machine with which direct white prints or blue prints may be made with equal facility, the operator being enabled to change from one to the other without stopping the machine. The equipment is automatic throughout, the paper being printed, washed and dried continuously, and delivered at the end of the dryer, automatically rolled up, ready for use. The entire equipment, which occupies a space only about 6½ ft. square, can be handled by one man, and it is possible to print, wash and dry from 50 to 100 yards of either the Pease direct white print paper or electric blue print paper per hour. One hundred and twenty changes of speed can be made directly through the motor with one gear change, thus enabling the operator to obtain great accuracy in exposure. No belts or friction devices are used; all parts are readily accessible for cleaning and trimming, without the use of screw driver or wrench. The white print apparatus is placed between the printer and washer, and is independent of either. It is so arranged that the time of development can be changed to suit varying conditions.

This company has just issued a 100-page catalogue, fully describing its line. Its exhibit during the week of the convention is in sections 161-162, at the Coliseum.

GOLDIE TIE PLATES AND SPIKES.

In the exhibit of Dilworth, Porter & Company, Limited, Pittsburgh, Pa., in space 26 at the Coliseum, are shown several types of Goldie tie plates, including the Dilworth shoulder flange plate and the Harriman type plate. Standard track spikes and the Goldie Perfect spikes are also being shown.

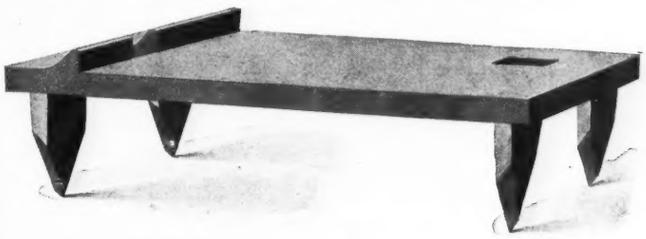
Goldie Standard Spike.

The Goldie tie plates are designed to unite with the tie and furnish the necessary resistance to spreading rails on curves. The four claws on the base of the plate serve as additional spikes, so that it is claimed that it is never necessary to use more than the usual two spikes to hold the gage on the sharpest curves and under the heaviest traffic. These plates are being used on the Park Street loop of the Boston subway, where no tie rods or rail braces have been found necessary, although the track is on a 50-degree curve.

The Glendon flange and Dilworth shoulder plates are alike except that the former has no shoulder on the top side. The Glendon flange plate is adapted for use on treated ties on tangent track (where the top shoulder is not as necessary as on curves), on account of its combination of strength and light weight. In designing the flange and Dilworth shoulder plates, special attention was given to the shape of the flanges, and these are so proportioned that a maximum holding power of a flange plate is obtained at a minimum damage to the grain of the wood.

The Harriman type of tie plate, as manufactured by Dilworth, Porter & Co., is in use on some of the largest roads in the country, being used on treated and soft-wood ties on tangent track, where it is not so necessary to have a gage-holding plate. This type of plate is the standard on all the Harriman Lines. This plate combines the necessary strength with lightness.

Dilworth, Porter & Co. have been manufacturing track spikes for over 50 years, and the spikes are now in use all over the United States. Every size of spike in general use is made by this company, the sizes ranging

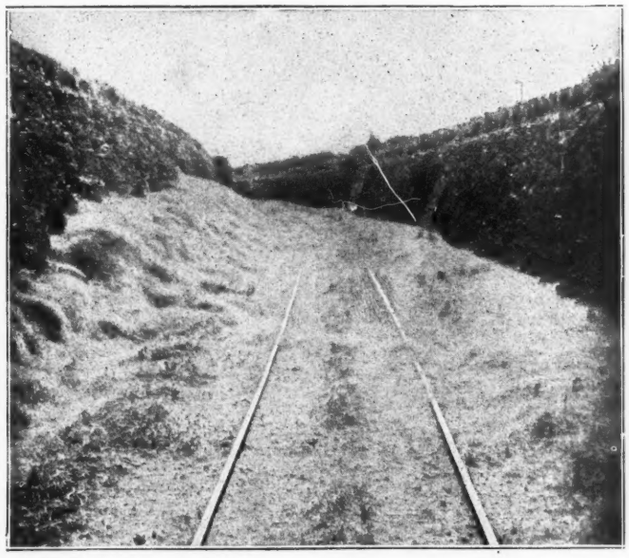


Goldie Tie Plate.

from 2½ in. by $\frac{5}{16}$ in. to 6½ in. by ⅝ in. All sizes of bolt and drift spikes are also made. The sharp-pointed spike, commonly known as the Goldie point, has greater adhesion in all kinds of wood than spikes of equal cross-section and length, since the sharp point affords easier penetration of the tie and destroys less fibre than does a chisel pointed spike.

WEED KILLING.

Weed destruction and elimination has been a permanent item of considerable size in the upkeep of the roadbed. The Atlas Preservative Company, London, has been for years meeting successfully the demand for a process which deals economically with this evil. Its experiences have been largely in the tropics where weeds and grasses grow in a very prolific manner. Many of the best known rail-



Flying Grass, on the Great Southern Railway.

ways in India, Argentine Republic, Borneo, Cape Colony, New Zealand and Brazil have tested this method for a number of years and have found it most successful. This process of weed killing consists of spraying the roadbed with water in which a solution of Atlas "A" has been mixed. Sprinkling cars of different types may be used to make the application. The active principle of Atlas "A" is the same which gives the preservative effect to Atlas boiler

compound, Atlas paints and Atlas wood preservative. Thus this means of killing vegetation is designed to happily combine this effect with the quality of preserving wooden ties from decay and keeping rails, bolts and plates free from corrosion. Some of the results obtained show remarkable economies. Thus, on one of the leading railways in the Argentine Republic the use of the preservative over a 50-mile section (distributed by means of an engine hauling a sprinkling tank, and accompanied by three men to mix the solution and watch over the distribution) has resulted in saving at the rate of $117 per mile per year, after allowing 10 per cent. for depreciation of the tank. In another case, on a New Zealand line, the action on the rails and ties themselves is declared to have been very beneficial. The disappearance of rust makes the bolts easy to tighten without risk of fracture, and the ties are kept clean and hard.

The first system to carry out practical tests on a sufficient scale and for a sufficient time positively to demonstrate results was the Buenos Aires Great Southern, which, after experimenting with preservative "A" from 1898 to 1901, steadily increased the mileage to which it has been applied, until in 1906 it was close to 800 miles.

The illustration shown herewith of a cut on the Great Southern of Argentina indicates clearly the nature of the difficulties with which railway engineers in that part of the world have to contend. The grass shown across the railway track is not growing on the line, but it has been blown there. At certain seasons of the year this grass becomes detached from its roots, and, the country being very flat, is blown long distances and becomes arrested in railway cuts, exactly in the same manner as snow. Being at the same time dry and full of seed, the latter is naturally deposited on the track in great quantities and there germinates unless preventive sterilization by Atlas preservative "A" has been resorted to.

The point of particular interest to American railway men is that the Atlas Preservative Company is now beginning active work in the United States through its American company, the Atlas Preservative Company of America. The company confidently expects that the success it has had in other countries will be duplicated here. This company's office is at 95 Liberty street, New York, with agencies in the principal cities of the United States.

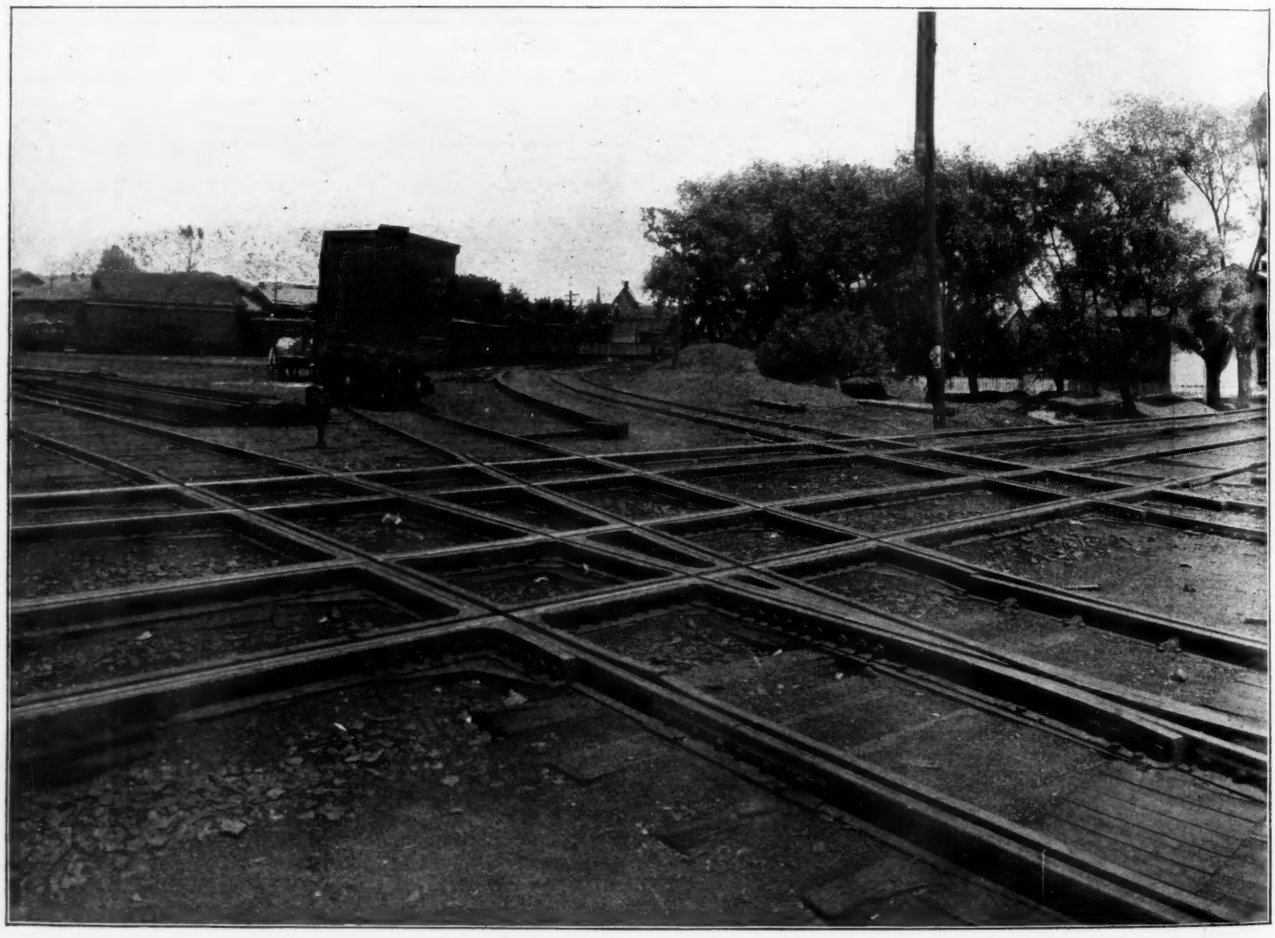
FROGS AND CROSSINGS.

The Pennsylvania Steel Company, Steelton, Pa., is exhibiting at the Coliseum in spaces 45-48, inclusive, and 64-67, inclusive, its line of rails, Manard steel frogs, switches, crossings and staple track appliances.

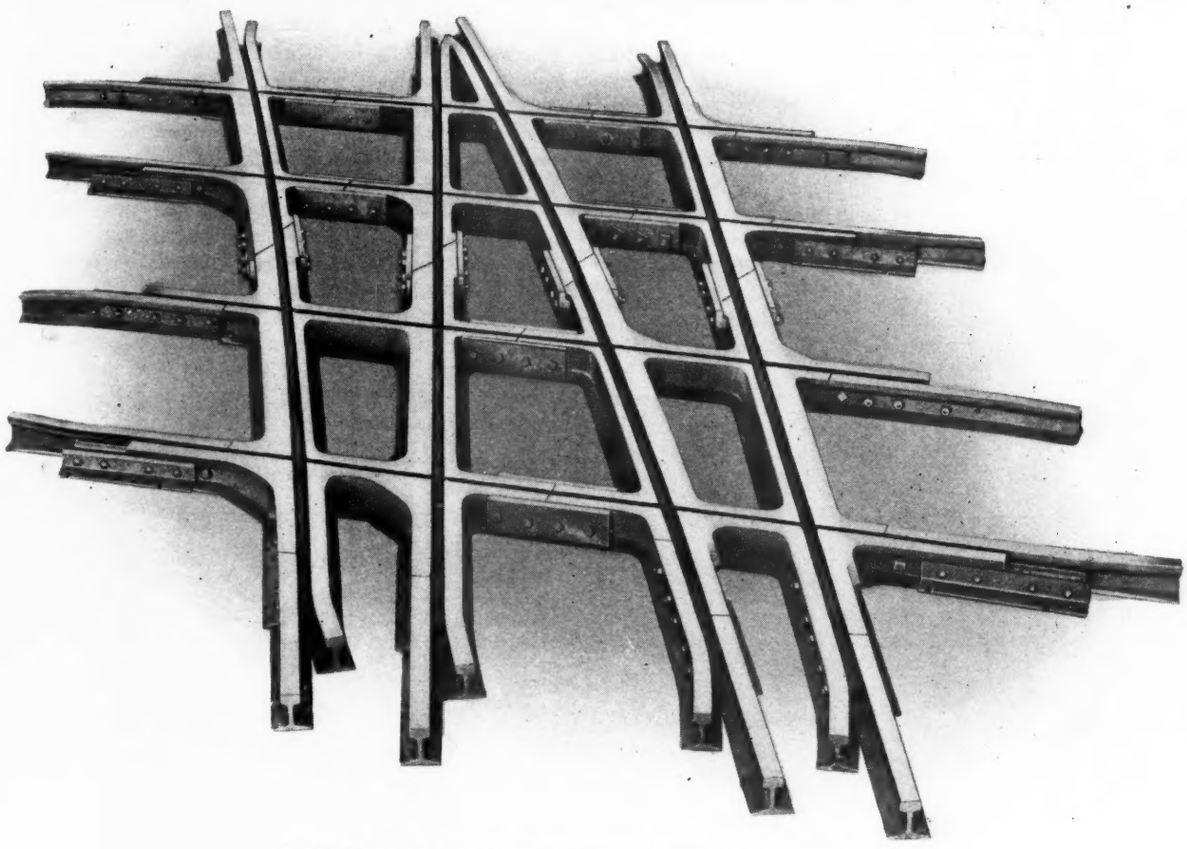
This company's plant occupies an extended area along the banks of the Susquehanna River east of Harrisburg, Pa. Its coal and ore mines, blast furnaces, Bessemer and open-hearth furnaces, rail mills, merchant steel mills, steel foundry, bridge and structural works and frog and switch works enable the company to keep every process of manufacture in its own hands.

The Pennsylvania Steel Company manufactures rails of all standard patterns, girder rails, including Trilby, half-groove, full-groove and girder guard types, high tee or Shanghai, flat or tram rails for bridges, slot and conductor rails for underground trolley construction. Its open-hearth furnaces have a capacity of 45,000 tons per month.

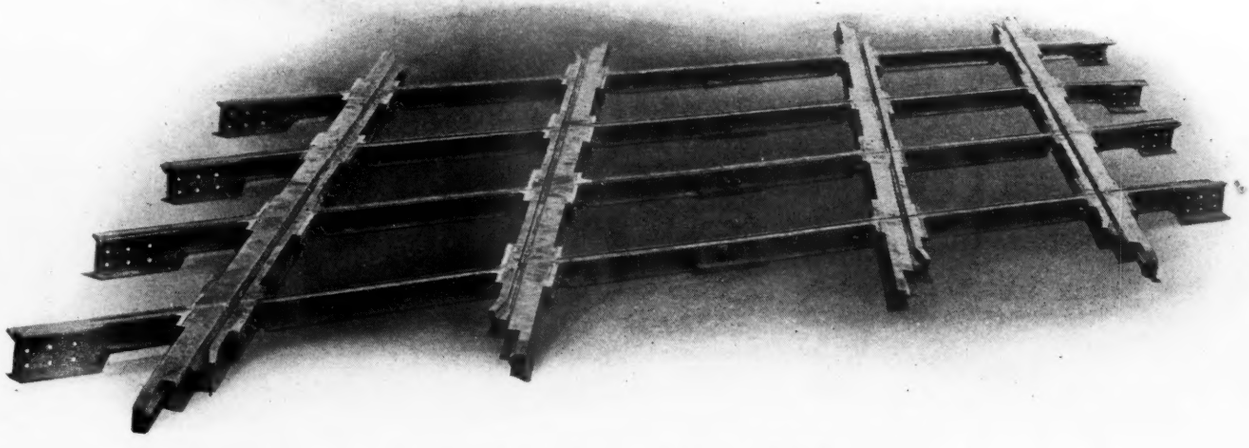
The bridge and construction department of the company built the Queensboro and Williamsburg bridges across the East River, New York, the Niagara arch bridge, the Gok-



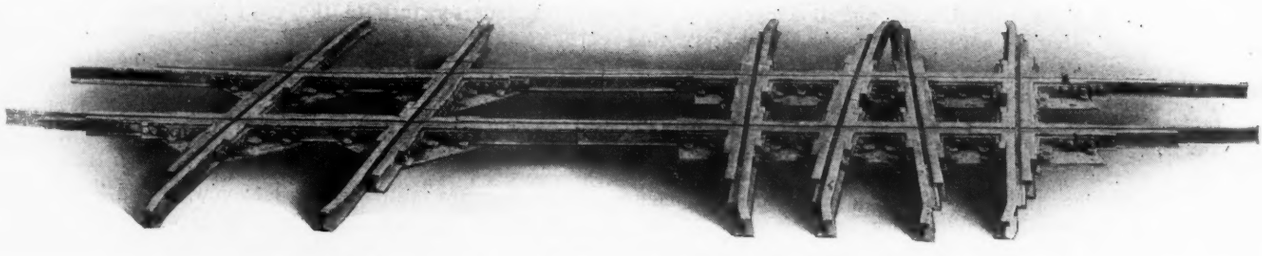
Manard Crossings on Pennsylvania Railroad at Sunbury, Pa.



Solid Manard Crossings for Ontario Construction Company.



Manard Crossings on Baltimore & Ohio.



Manard Crossings on Pennsylvania Lines West at Bucyrus, Ohio.

teik viaduct in Burmah, British India, and numerous steel structures in the larger cities of the country.

The frog and switch department covers 25 acres and the output of track work is said to be larger than that of any similar establishment.

The Manard anvil face frog, design 160, is a hard centre frog for main line traffic. The centre is made of Manard steel, a high quality of manganese steel. Solid Manard frogs, switches, mates, crossings and special work layouts for all conditions of service are specialties. Switch stands of all approved designs are manufactured. The switches for steam roads made under the Vaughn patents are also manufactured in the frog and switch department.

The Never-slip interlock switch plate, rolled from the finest steel blooms, with solid riser and a turned shoulder to hold the brace tightly against the stock rail, forms a practical rail lock and has met with favor, superseding in many cases the forged plate with struck-up, hot-pressed riser.

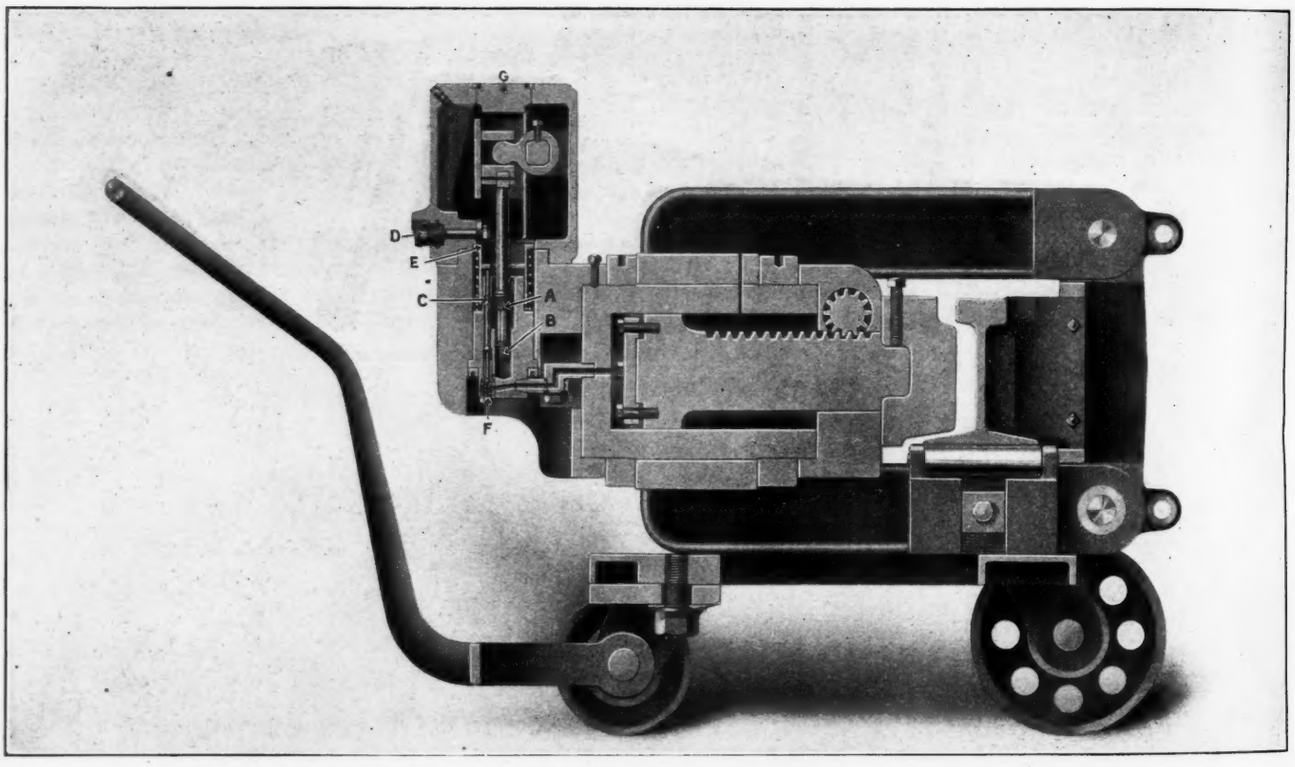
The Never-turn bolt has a head forged to fit the head and flange of the rail, set at an angle to make the lateral fit to the web of the rail. To further provide against the loosening of the nut, the bolt is split before being threaded and a long nut is furnished. After the nut is tightened the split is spread to engage the threads of bolt and nut firmly, thus obviating the use of a nut lock. As the bolt stretches under strain the nut may be removed and again placed on the bolt, which is split as before, and this operation may be repeated as often as necessary. Tests have shown that the Never-turn bolt has many times the resistance to vibration of the ordinary bolt.

Among the many recent installations secured by this department are the track work for the New York terminal of the Pennsylvania Railroad and that of the Vera Cruz terminal in Mexico. These consisted of an entire equipment in each case of frogs, switches, slips, crossings and all connections, and an innovation in frog construction was introduced for the Vera Cruz terminal in that a solid base plate was a integral part of a solid cast Manard frog.

HYDRAULIC RAIL BENDER.

The new portable rail bender shown in the accompanying illustration has been put on the market by Richard Dudgeon, New York. It is different from the usual hydraulic rail bender in that it is made on the principle of the Universal jack and uses a pressure of 6,000 lbs. per sq. in., which is somewhat less than ordinarily used in rail benders. Where possible its parts are made the same as those in the Universal jack, which make repairs less difficult and reduces the number of necessary repair parts where both these machines are used.

The frame of the bender is made of high-grade steel castings and the cylinder, ram and similar parts are made of steel forgings. The ram is fitted with a rack and pinion by which it may be run out against the rail, thus eliminating the labor of pumping it out, the chamber behind the ram being filled with the fluid by suction so that the first stroke of the lever is against pressure. The pump is

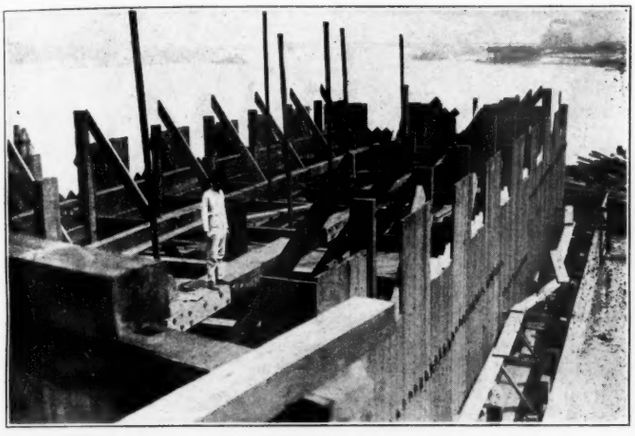


Dudgeon Hydraulic Rail Bender.

equipped with two plungers, A and B, so arranged that A may be thrown out of service when the final pressure is applied. This feature saves time and labor. To throw plunger A out of service, the handle D is turned so that it extends downward. This handle operates a cam which pushes the bushing E down on the stem of the stop valve C, forcing it from its seat and thus by-passing the fluid under plunger A back to the reservoir. By turning the handle D another quarter turn to the right the bushing E is forced still further down, forcing all the valves from their seats. The pressure is thus released from behind the plunger, which may then be pulled back by the pinion and rack. By this arrangement the valve seats may easily be kept clean, as the fluid can be made to pass both ways over them, washing away any grit that should by chance collect there. The valves are easily removed by unscrewing the bonnet F in the bottom of the pump, and the piston and plungers by unscrewing the plate G. The other parts are as conveniently removed, making the machine as simple in repairs as in operation.

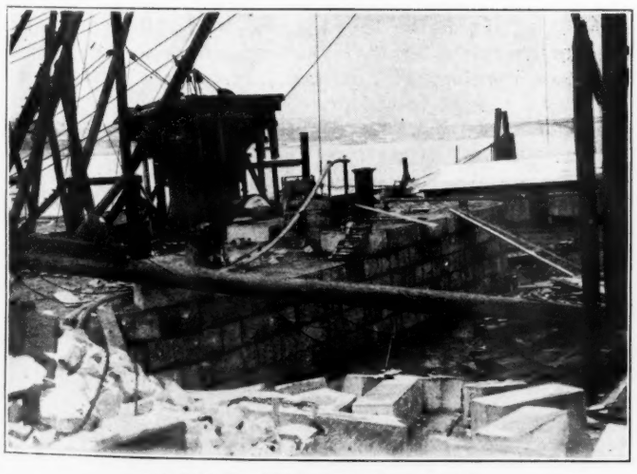
ST. LOUIS MUNICIPAL BRIDGE.

The municipal bridge which is now being built across the Mississippi River at St. Louis, Mo., is a double deck structure with a highway on the upper level and railway tracks on the lower, being designed to carry two railway tracks, two trolley tracks on a 30-ft. roadway, and two 6-ft. sidewalks. The bridge is carried on piers sunk to rock by the use of pneumatic caissons. The contract for the four river piers was let to the Missouri Valley Bridge & Iron



Pier Being Launched From Barge.

Company, Leavenworth, Kan., and work on them began in the latter part of 1909. The caissons were built inside pontoons or barges and launched from them into the river. Fig. 1 shows one of the caissons about ready for launching. Fig. 2 shows the masonry complete above the water level with the barge lying back of the pier. At present pier No. 1 is completed and piers 2, 3 and 4 are completed



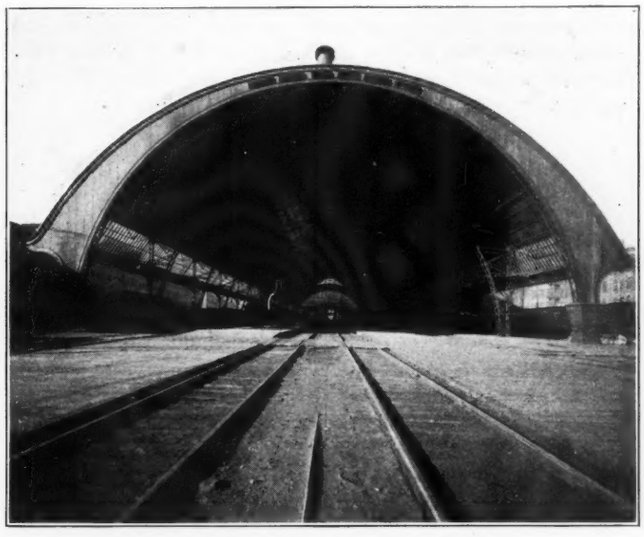
Pier Completed to Water Level.

below the water line. Piers 3 and 4 will be completed first in order to allow the building of the east span as soon as the high water subsides.

THE ANTI-PLUVIUS SKYLIGHTS.

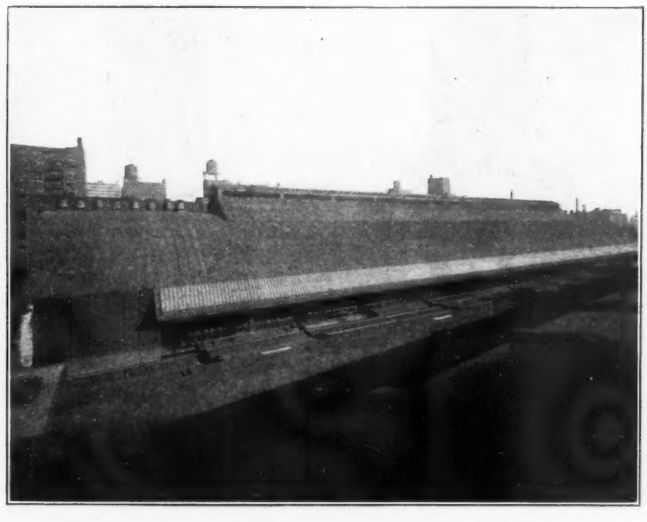
Sometime ago it became necessary to renew the roof of the train shed at the Grand Central station, Chicago, which includes 24,600 square feet of skylight surface. The roof as completed is shown in the two photographs reproduced herewith. The skylights are fitted with "Anti-Pluvius" metal frames and wire glass. These skylight frames are built in units, making their direction easy and allowing the removal of any pane of glass without difficulty.

The frame is composed of a supporting bar made of a high carbon steel, containing inverted stirrups at intervals of 16 to 20 inches. Flat plates covered with strips of hair felt rest on these stirrups and support the skylight glass. A similar strip of felt is placed on the upper side of the



End View of Train Shed.

glass and is held in place by a metal cap. Brass studs are screwed into the stirrups and project up through the plates between the panes of glass. They are equipped with phosphor bronze springs which bear on the upper side of the metal cap and on the under side of a shoulder provided near the upper end of the stud. This spring furnishes an



Side View of Train Shed, Showing Skylights.

elastic pressure to hold the skylight glass securely in place. The stirrups in the steel supporting bar hold the glass above the lips of the bar so that in locations where condensation on the skylights is common a large part of the trouble is eliminated since the glass is not in contact with any of the metal in the frame. The hair felt used is a non-rotting material which has been produced after considerable experimenting. Inverted "U" bars are carried on the upper shoulder of the brass studs at a distance of a few inches from the glass. These bridges are easily able to bear a man's weight and provide a means of ready access to all parts of the skylight. All the exterior metal trim-

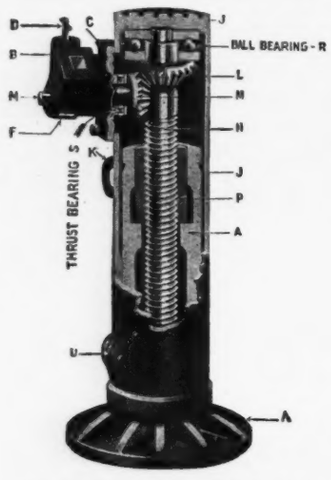
mings of these frames are of Toucan metal, which has exceptional rust and corrosion resisting properties.

These skylight frames have been used in many train shed installations throughout the country and are also being extensively used for street railway car barns. Two of the large car barns of the Chicago Street Railways Company are equipped with them and two bays have recently been added to the barn at Thirty-eighth street and Archer avenue, requiring a large quantity of these puttyless frames.

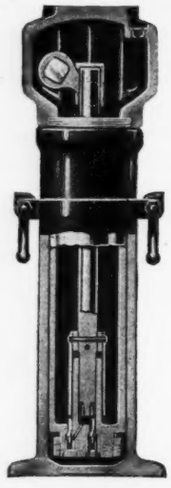
The Anti-Pluvius frames are made by the G. Drouve Company, Bridgeport, Conn., and models are on exhibit in Booth 163 at the Coliseum.

JACKS.

All railway men interested in lifting jacks will appreciate the large display of ratchet, geared, ball-bearing and hydraulic jacks by Fairbanks, Morse & Co., Chicago, at the Railway Appliances Exhibition, spaces 73, 74, 75, 76 and 92, 93, 94 and 95, at the north end of Coliseum. The different departments of railways require different types of jacks. The quick acting ratchet lever jack has been adapted to track work, and is now an absolute necessity to many track men. The standard No. 1 track jack has a capacity of 10 tons. Next comes the 15-ton capacity jack used for heavier track work, and also for light car repairs in the mechanical department, but as 15 tons is about the limit of



Fairbanks-Morse Ball Bearing Jack, Sectional View.



Duff-Bethlehem Hydraulic Jack, Sectional View.

easy operation with a ratchet jack, the geared jack has been brought out, having from 20 to 40 tons capacity, and has displaced, to a certain extent, the slow moving screw and hydraulic jacks. Until a short time ago the heaviest geared jack was of 35 tons capacity. However, with the advent of heavier rolling stock, particularly the steel gondolas and large steel frame box cars, the necessity arose for a heavier jack, which has been perfected by the Duff Manufacturing Co., and styled "No. 400," of 40 tons capacity. Special features distinguished this jack from the lighter ones and all parts have been worked out with the idea in view of having a well proportioned, safe jack, exceptionally large bearings, and an independent set of raising and lowering parts outside of the gear and pinion.

The distinguishing features of the ball-bearing jacks sold by Fairbanks, Morse & Co. are clearly shown in the sectionalized jack they have on display. In these jacks, the balls are made very large and are separated from each other by a brass cage, each ball being free from the other, minimizing the friction. The balls do not run on a flat surface, but in a groove, which gives a greater bearing and results in the balls standing a heavier load without crushing than if on a flat plate. Another distinctive feature is the roller thrust bearing back of the bevel gear, to reduce wear on the gears and make operation of the jack easier by reduction of friction at that point.

The new Duff-Bethlehem hydraulic jacks exhibited by Fairbanks, Morse & Co. are made of forged steel, thereby reducing the weight about one-third without reducing the capacity. Another important feature of this jack, probably the most important and one that appeals instantly to railway men experienced in handling hydraulic jacks, is the absence of any joint and packing at the base. The base and cylinder are in one solid forging, giving no opportunity whatever for leakage, which is the most common trouble. The head is cast steel and the ram is forged integrally with the pump, having no threads. The valves are only two in number, parallel system, working independently of each other. These jacks can be used at any angle.

HOLMEN COALING STATION AT DELMAR, IND.

The coaling station illustrated herewith is a 500-ton Holmen plant, built at Delmar, Ind., for the Cleveland, Cincinnati, Chicago & St. Louis by the Roberts & Schaefer Company, Chicago, under the jurisdiction of O. E. Selby, Cincinnati, Ohio, engineer of bridges and buildings of the railway.

The railway now has under construction at Mattoon, Ill., a Holmen plant of this general design but with a storage capacity of 800 tons of coal, and at Greensburg, Ind., it is having built by the same contractors a 500-ton Holmen plant, similar to the Delmar station, with the exception that in the latter case the entire sub-structure and bin trusses are structural steel encased in concrete.

The station at Delmar consists of a frame superstructure, with steel bin trusses supporting a 500-ton bin for coal, which is elevated on posts high enough to let the coal flow from a storage bin by gravity into the tenders, this being accomplished by the installation of standard undercut gates with hooded aprons over the two main line tracks.

At the right of the bucket tower is a 36-ft. concrete receiving hopper under the unloading track on which loaded cars are run in. This hopper is covered with a canopy roof with side enclosure to protect men from the weather when unloading coal. The coal from the track hopper passes into two Barrett patent revolving measuring feeders, which measure a given quantity of coal and automatically discharge this load into the two 1½-ton Holmen buckets. It is not necessary for the operator to watch the loading of the buckets, as this is accomplished automatically. The two Holmen buckets are located alongside each other and are elevated alternately. When one bucket is in the bottom of the pit being filled, the other is at the top of the plant discharging its load of coal into the storage bin.

Each bucket is attached to a ⅞-in. crucible steel wire cable connected to a reversible steam hoist. The sheaves at the top of the tower are of liberal size to insure long life and easy movement of the cable. The small amount of machinery necessary in a Holmen station insures a minimum expense for up-keep.

The bucket elevating the coal is opened at the top automatically at the proper elevation to deliver the coal to the pocket with a minimum amount of breakage and is also closed automatically after being emptied. As the bucket descends, it is immediately filled at the bottom with coal by the revolving feeder in the pit.

The operation of filling the buckets and hoisting the coal and delivering it to the storage bin is under the control of one man, who merely operates the lever on the hoisting engine to put in operation the feeders and elevating machinery.

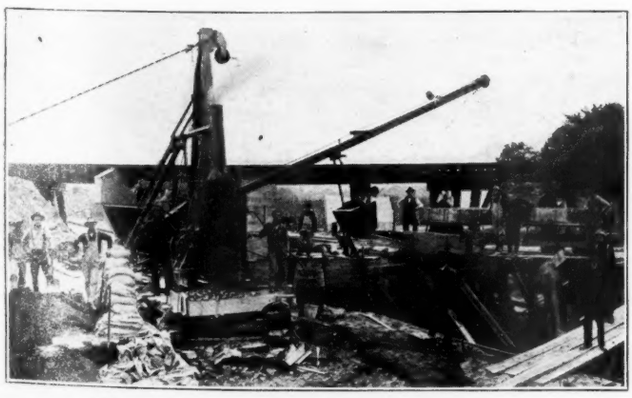
The average time required to fill and elevate a bucket of

coal is usually about one minute, and with two 2½-ton Holmen buckets an elevating capacity of 125 tons per hour can readily be attained. This machinery is also designed to elevate 40, 60 or 75 tons per hour, according to the requirements of the station, the plant built at Delmar being designed with a 60-ton elevator.

Holmen Coaling Station at Delmar, Ind.

CHICAGO IMPROVED CUBE MIXER.

In drawing up plans and specifications for work the engineer usually insists that none but the best material shall be used and that the manipulation of the material shall be such as will result in a finished product which will be the best that can be obtained by the most modern methods. In doing this work the contractor looks for means to comply with these specifications with the minimum of cost to himself. In selecting a mixer he investigates carefully the speed of charging, speed of mixing, speed of discharging, strength and uniformity of concrete and cost of maintenance. A large number of important public and private works, among them the Panama canal and the Michigan Central tunnel under the Detroit River, on which the Chicago improved cube mixers, made by the Municipal Engineering & Contracting Company, Chicago, were used exclusively, testify to the way in which they fulfil these requirements. The accompanying view shows a cube mixer mounted on skids in connection with a steam engine and boiler. It is equipped with a charging elevator and a boom attachment for delivering concrete at some distance.



Chicago Improved Cube Mixer, With Boom.

A MODERN FORM OF LIGHTNING ARRESTER.

The lightning arrester problem has always been a difficult one for the signal department to solve. It has been no less difficult for the manufacturer who went into the problem with sincere intention of aiding the signalman in his troubles. At first glance, the problem seems simple. An alternating current in one line will induce similar currents in a parallel line, and, to a less extent, in its own line. Prior to the great demand for arresters for signal material there had developed a large field for arresters in telephone, telegraph and power circuits. Arresters designed for each of these types of service have given quite satisfactory results, but a careful study shows that they have been designed by men thoroughly familiar with the subject and that they are incapable of transfer from one branch of service to another. Arresters for the three types of service just mentioned, each have one prime function, namely, to save the apparatus which they protect by immediately destroying the use of the circuit for the time being.

Arc Damp Lightning Arrester.

Arresters for signal service must fill just the opposite requirement in this regard. They are not located at convenient points in power houses or sub-stations, but are scattered out along the line at the different signals and relay boxes, and they must not put the line out of business, but must immediately restore it to working order as soon as the abnormal conditions in the atmosphere disappear. It was on this point that the ordinary choke coil with saw teeth, discharge gap and ground plate, early developments in the making of an arrester for signal service, ultimately failed to fill the requirement. Practically all such arresters were designed with a fuse in series, and it was not uncommon to have a discharge blow the fuse and put the signal entirely out of service until the fuse was replaced.

Careful laboratory study revealed another serious defect in the usual open-gap choke coil arrester. None of these arresters would arc to ground at less than 2,000 or, possibly, 3,500 volts. If the easiest path to ground was between two saw teeth, it is apparent that with each discharge the gap between the teeth was widened by burning off the point and the ordinary breaking down voltage was raised with each successive discharge.

Insulation tests of coils, relays and other apparatus indicated that they could be punctured by 3,000 volts, and in some cases less than this, and that the insulation around the binding posts would also break down at about the same pressure. Taken at the best it was a question whether the lightning arrester would protect the relay, or the relay would

protect the lightning arrester, and it soon became apparent that the arrester must have a low point of break down relative to the instrument it protected.

Other features of failure were common in early types of arrester. It became permanently grounded by fusing of metal across the air gap, or lodgment of foreign particles, such as small pieces of coke or bugs, or, drops of water in the air gap. Sometimes the arrester was structurally weak and broke, allowing the choke coils to fall against the ground plate. Occasionally after the arc was established by the lightning, it was continued by the normal circuit after the charge had ceased. All these failures were common enough to make it plain that they must be avoided in a satisfactory design of arrester.

About five years ago some interesting experiments were made by engineers high up in the signaling profession, and from these experiments, a type of arrester at that time considered novel, was developed and placed on the market as the Arc-Damp lightning arrester. This device had no choke coil and no fuse. It was not part of the line proper, but was a multiple between the line and ground. It consisted of a spark gap, many times smaller than anything that had been attempted in the usual open gap arrester.

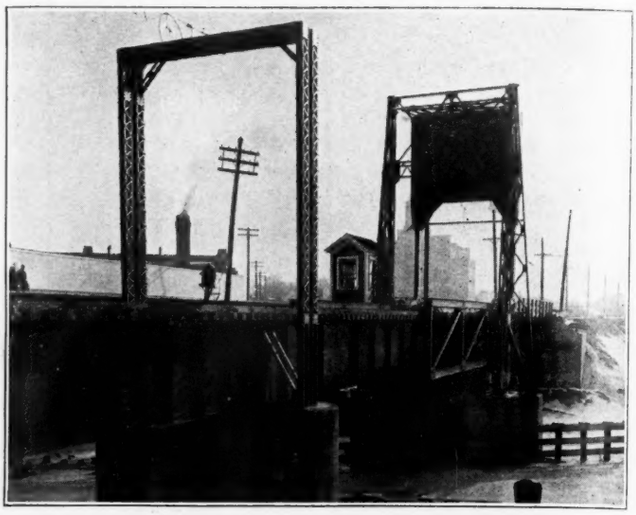
In series with this gap was a block of high resistance material. This material was practically a non-conductor to the usual low-voltage working circuit, but to the high-frequency discharge it was a satisfactory conductor. Repeated discharges would raise its temperature and lower its resistance, thereby increasing the capacity of the arrester under severe conditions. No matter, however, how low its resistance might fall under strenuous service, it was capable of restoring the line to normal and preventing the discharge of working circuit to ground as soon as the abnormal condition ceased. The gap was so protected that foreign particles could not enter, and even should the metal faces of the gap fuse across, there was enough resistance in the block in series with the gap to prevent the working circuit becoming grounded. The total internal resistance of the device was very much lower than that of the usual choke coil, and its relation to the point of break down in relays and other apparatus was very much more satisfactory.

The Arc Damp lightning arrester was well received from the start. It was somewhat more expensive than the usual choke coil, but was much more effective, and when tried on a road, its use was very generally continued. As is natural in all new devices, extended service showed that certain structural corrections would improve the device and these have been made.

To-day what may be called the Arc Damp type of arrester is the only type that receives serious consideration in the signal department. The usual number of imitations have naturally followed, but the Arc Damp stands preeminent in the field. Since it was first marketed, it has been handled by the Railway Specialty & Supply Co., whose name is now The P. & M. Co., Chicago. The company has an exhibit of several of the devices in booth 123 at the Coliseum.

PLATE GIRDER BASCULE SPAN.

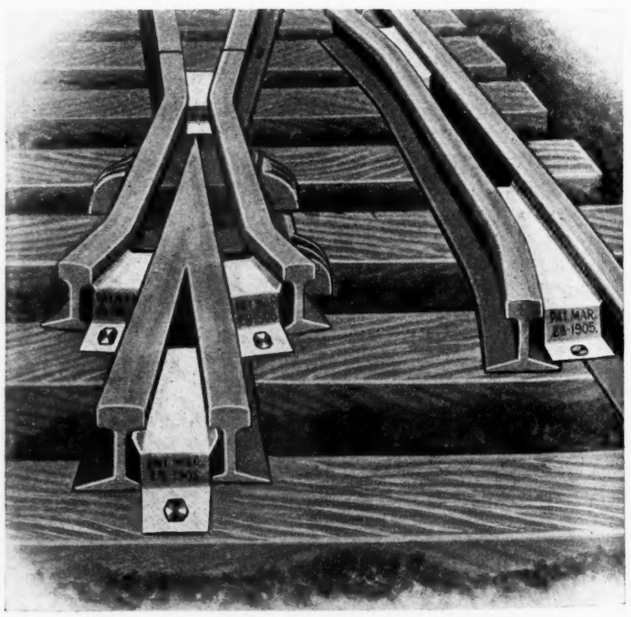
A particularly interesting adaptation of a Strauss bascule bridge is shown herewith. It consists of a pair of standard deck plate girders of the shortest possible length for the required clear opening, connected to a pair of lifting trusses provided with the Strauss counterbalancing arrangement. The result is an economical structure, the component parts being reduced to simple terms. Any standard deck girder may be converted into a movable span in this manner, the economical length limit being about 100 ft. The illustration shows a 70-ft. single-track span for the Ohio Electric Railway at Toledo, Ohio, the approach spans also being 70 ft., and interchangeable with the bascule span. There is now nearing completion a double-track bridge of this type for the Canadian Northern at Winnipeg, Man., the span length being 100 ft. Two bridges of the same type are also in use on the Florida East Coast, and others are under construction for the New York, New Haven & Hartford and the Toronto Hamilton Railway. These bridges are made by the Strauss Bascule Bridge Co., Chicago.



Strauss Bascule Bridge Over Swan Creek at Toledo, Ohio.

ECONOMY FOOT GUARD.

The Economy foot guard is made of No. 10 sheet steel, and is secured in place with an ordinary bolt or track spike, as shown in the accompanying cut. In many states the law requires the use of some protection in frogs and switches, wooden blocks being used in many cases for this purpose. The decaying of such blocks makes their renewal necessary at intervals and the metal guard is made to overcome this difficulty.



Economy Foot Guard.

The Economy guard requires no renewal and always presents a neat appearance in the track.

The Economy guard is made by the Economy Separable Switch Point Company, Louisville, Ky.